UNIVERSITY OF CALIFORNIA PUBLICATIONS

REPORT

OF THE

COLLEGE OF AGRICULTURE

AND THE

AGRICULTURAL EXPERIMENT STATION

OF THE

UNIVERSITY OF CALIFORNIA

From July 1, 1922, to June 30, 1923

UNIVERSITY OF CALIFORNIA PRINTING OFFICE
BERKELEY, CALIFORNIA
1923

CONTENTS

COLLEGE OF AGRICULTURE

AND THE

AGRICULTURAL EXPERIMENT STATION

THE STAFF

David P. Barrows, Ph.D., LL.D., President of the University of California.

Thomas Forsyth Hunt, D.Agr., D.Sc., Dean of the College of Agriculture, Professor of Agriculture.

...., Director of Resident Instruction.

C. M. Haring, D.V.M., Director of Agricultural Experiment Station, Professor of Veterinary Science.

B. H. Crocheron, M.S.A., Director of Agricultural Extension, Professor of Agricultural Extension.

F. H. Abbot, B.S., Extension Specialist in Butter Standardization, Davis.

Frank Adams, A.M., Professor of Irrigation Investigations and Practice, Davis.

Richard L. Adams, M.S., Professor of Farm Management.

J. W. Adriance, B.S., Specialist in Agricultural Extension.

F. W. Allen, M.S., Assistant Professor of Pomology, Davis.

H. T. Anderson, B.S., Assistant in Agricultural Extension.

C. L. Austin, B.S., Assistant in Pomology, Davis.

†H. J. Baade, B.S., Assistant Professor of Agricultural Extension.

E. B. Babcock, M.S., Professor of Genetics.

*L. C. Barnard, B.S., Assistant in Pomology, Davis.

J. T. Barrett, Ph.D., Professor of Plant Pathology, Associate Director of Citrus Experiment Station, and Associate Dean of the Graduate School of Tropical Agriculture, Riverside.

E. T. Bartholomew, Ph.D., Assistant Professor of Plant Pathology in Citrus Experiment Station and Graduate School of Tropical Agriculture, Riverside.

D. T. Batchelder, B.S., Specialist in Agricultural Extension.

L. D. Batchelor, Ph.D., Professor of Farm Management in Citrus Experiment Station and Graduate School of Tropical Agriculture, Riverside.

W. E. Bates, M.D., Lecturer in Hygiene, Davis.

*Mrs. Hope Baxter, B.S., Assistant in Agricultural Extension.

J. R. Beach, D.V.M., Assistant Professor of Veterinary Science.

S. H. Beckett, B.S., Associate Profesor of Irrigation Investigations and Practice, Davis.

H. L. Belton, Associate in Agricultural Engineering, Davis.

J. P. Bennett, Ph.D., Assistant Professor of Pomology.

Katherine E. Bennitt, B.S., Assistant in Agricultural Extension.

J. P. Benson, B.S., Assistant Professor of Agricultural Extension.

W. E. Berg, B.S., Associate in Agricultural Education.

F. T. Bioletti, M.S., Professor of Viticulture and Fruit Products.

C. S. Bisson, Ph.D., Professor of Chemistry, Davis.

Edna A. Black, Assistant in Agricultural Extension.

V. F. Blanchard, B.S., Assistant in Agricultural Extension.

M. B. Boissevain, B.S., Specialist in Agricultural Extension.

Leon Bonnet, I.A., Associate in Viticulture, Davis.

H. A. Borthwick, A.B., Assistant in Botany, Davis.

*C. L. Brewer, B.S., Professor of Physical Education and Director of Athletics, Davis.

W. H. Brooks, B.S., Assistant in Agricultural Extension.

J. B. Brown, B.S., Extension Specialist in Irrigation, Davis.

S. M. Brown, Assistant Chemist in Citrus Experiment Station, Riverside.

Donald Bruce, M.F., Associate Professor of Forestry.

†V. C. Bryant, M.S., Assistant Professor of Agricultural Extension.

J. S. Burd, B.S., Professor of Plant Nutrition.

* Resigned. † Leave of absence.

Helen A. Burling, M.S., Assistant in Agricultural Extension.
Clarence J. Burrell, B.S., M.Di., Associate in Mathematics, Davis.
Austin M. Burton, B.S., Specialist in Agricultural Extension.
Melvin W. Buster, B.S., Assistant in Agricultural Extension.
H. M. Butterfield, M.S., Supervisor of Agricultural Correspondence Courses.
Elsie L. Calkins, M.S., Assistant in Agricultural Extension.
W. R. Camp, Ph.D., Associate Professor of Rural Institutions.
E. J. Campbell, B.S., Assistant in Agricultural Extension.
*F. A. Carlson, Ph.D., Assistant Professor of Soil Technology, Davis.
*W. F. Carroll, B.S., Assistant in Agricultural Extension.
A. W. Christie, M.S., Assistant Professor of Fruit Products.
Lillian D. Clark, Specialist in Agricultural Extension.
W. T. Clarke, B.S., Professor of Agricultural Extension.
R. E. Clausen, Ph.D., Assistant Professor of Genetics.
Susan F. Cobb, M.A., Associate in English, Davis.
J. E. Coke, B.S., Assistant in Agricultural Extension.
J. L. Collins, Ph.D., Instructor in Genetics.
M. D. Collins, B.S., Specialist in Agricultural Extension.
C. M. Conner, Assistant Professor of Agricultural Extension.
*Evelyn Conklin, B.S., Assistant in Agricultural Extension.
J. P. Conrad, B.S., Associate in Agronomy, Davis.
W. M. Cory, B.S., Assistant in Agricultural Extension.
S. W. Cosby, B.S., Research Associate in Soil Technology.
W. V. Cruess, B.S., Associate Professor of Fruit Products.
W. H. Cudaback, B.S., Assistant in Agricultural Extension.
A. B. Cummins, B.S., Assistant in Agricultural Chemistry, Riverside.
*E. W. Curtis, B.S., Specialist in Agricultural Extension.
A. R. Davis, Ph.D., Assistant Professor of Plant Nutrition.
Frank Davis, B.S., Assistant in Irrigation Investigations and Practice, Davis.
Ada L. Day, B.S., Assistant in Agricultural Extension.
L. H. Day, Associate in Pomology, Davis.
Jessie L. F. Decker, Assistant in Agricultural Extension.
*A. E. deFremery, B.S., Associate in Farm Management.
E. R. deOng, M.S., Instructor in Entomology.
V. W. DeTar, B.S., Assistant in Agricultural Extension.
Ethelwyn Dodson, B.S., Specialist in Agricultural Extension.
W. H. Dore, B.S., Assistant Professor of Plant Nutrition.
J. E. Dougherty, B.S., Associate Professor of Poultry Husbandry, Davis.
Constance Douglas, A.B., Assistant in Agricultural Extension.
J. F. Duggar, M.S., Lecturer in Agronomy, Davis.
W. P. Duruz, M.S., Assistant in Pomology, Davis.
Maybell S. Eager, A.B., Assistant in Agricultural Extension.
R. B. Easson, B.S., Specialist in Agricultural Extension.
Harriet G. Eddy, A.B., Assistant Professor of Agricultural Extension.
Raymond Ellis, Assistant in Agricultural Extension.
C. F. Elwood, B.S., Assistant Professor of Agricultural Extension.
H. E. Erdman, Ph.D., Associate Professor of Rural Institutions.
F. H. Ernst, B.S., Assistant in Agricultural Extension.
E. O. Essig, M.S., Associate Professor of Entomology.
H. P. Everett, B.S., Assistant in Agricultural Extension.
F. R. Fairchild, M.D., Surgeon at the University Farm School, Davis.
A. W. Farrell, B.S., Assistant in Dairy Industry, Davis.
Hilda Faust, M.A., Specialist in Agricultural Extension.
H. S. Fawcett, Ph.D., Professor of Plant Pathology in Citrus Experiment Station and Graduate School of Tropical Agriculture, Riverside.
L. J. Fletcher, B.S., Associate Professor of Agricultural Engineering, Davis.
C. L. Flint, B.S., Instructor in Landscape Gardening and Floriculture.
A. H. Folger, B.S., General Supervisor of Official Advanced Registry Tests, Davis.
R. D. Foot, B.S., Assistant in Agricultural Extension.
J. G. France, B.S., Instructor in Agricultural Extension.
E. E. Frasher, Assistant in Agricultural Extension.

* Resigned.

S. B. Freeborn, B.S., Assistant Professor of Entomology.
Emanuel Fritz, M.E., M.F., Assistant Professor of Forestry.
H. B. Frost, Ph.D., Research Associate in Plant Breeding in Citrus Experiment Station and Graduate School of Tropical Agriculture, Riverside.
E. L. Garthwaite, B.S., Specialist in Agricultural Extension.
W. F. Gericke, Ph.D., Assistant Professor of Plant Nutrition.
A. F. Gillette, B.S., Assistant in Agricultural Extension.
W. E. Gilfillan, B.S., Assistant in Agricultural Extension.
J. W. Gilmore, M.S.A., Professor of Agronomy.
*G. A. Goatley, B.S., Assistant in Agricultural Extension.
Gillette E. Gordon, B.S., Assistant in Agricultural Extension.
Harold Goss, B.S., Instructor in Nutrition.
S. S. Gossman, B.S., Assistant in Poultry Husbandry.
H. E. Graser, B.S., Specialist in Agricultural Extension.
*J. F. Grass, Jr., B.S., Specialist in Agricultural Extension.
†J. W. Gregg, B.S., Professor of Landscape Gardening and Floriculture.
F. L. Griffin, M.S., Associate Professor of Agricultural Education.
A. R. C. Haas, A.M., Ph.D., Assistant Professor of Plant Physiology in Citrus Experiment Station and Graduate School of Tropical Agriculture.
B. L. Hagglund, B.S., Itinerant Assistant in Agricultural Extension.
F. F. Halma, B.S., Assistant in Plant Physiology, Riverside.
J. B. Hammon, B.S., Assistant in Agricultural Extension.
William Harrison, Specialist in Agricultural Extension.
G. H. Hart, D.V.M., M.D., Associate Professor of Veterinary Science.
F. M. Hayes, D.V.M., Associate Professor of Veterinary Science, Davis.
J. C. Hays, B.S.A., Assistant in Agricultural Extension.
A. H. Hendrickson, M.S., Assistant Professor of Pomology, Mountain View.
G. W. Hendry, B.S., Assistant Professor of Agronomy, Davis.
M. J. Heppner, M.S., Assistant in Pomology, Davis.
W. B. Herms, M.A., Professor of Parasitology.
J. P. Hertel, B.S., Assistant in Agricultural Extension.
P. L. Hibbard, B.S., Assistant Professor of Plant Nutrition.
D. R. Hoagland, M.S., Associate Professor of Plant Nutrition.
R. W. Hodgson, M.S., Specialist in Agricultural Extension.
A. H. Hoffman, E.E., Assistant Professor of Agricultural Engineering, Davis.
L. C. Holmes, Specialist in Agricultural Extension.
W. B. Hooper, B.S., Extension Specialist in Walnut Culture.
W. T. Horne, B.S., Associate Professor of Plant Pathology.
W. L. Howard, Ph.D., Professor of Pomology, Davis.
C. E. Howell, M.S., Assistant Professor of Animal Husbandry, Davis.
M. R. Huberty, B.S., Assistant in Irrigation Investigations and Practice, Davis.
E. H. Hughes, M.S., Associate Professor of Animal Husbandry, Davis.
T. Francis Hunt, B.S., Associate Professor of Agricultural Extension.
C. B. Hutchison, M.S., Director of the Branch of the College of Agriculture, Professor of Plant Breeding, Davis.
H. E. Jacob, M.S., Assistant in Viticulture, Davis.
M. E. Jaffa, M.S., Professor of Nutrition.
C. N. Johnston, B.S., Assistant in Irrigation Investigations and Practice, Davis.
J. C. Johnston, B.S., Instructor in Citriculture.
B. J. Jones, B.S., Assistant Professor of Agricultural Extension.
H. A. Jones, Ph.D., Associate Professor of Truck Crops, Davis.
Katherine D. Jones, B.S., Associate in Landscape Gardening.
A. A. Jungerman, M.S., Specialist in Agricultural Extension.
H. B. Keller, B.S., Assistant in Agricultural Extension.
W. P. Kelley, Ph.D., Professor of Agricultural Chemistry in Citrus Experiment Station and Graduate School of Tropical Agriculture, Riverside.
P. B. Kennedy, Ph.D., Associate Professor of Agronomy.
O. J. Kern, Assistant Professor of Agricultural Education.
R. H. Klamt, B.S., Assistant in Agricultural Extension.
Hugh Knight, Assistant in Entomology, Riverside.
*K. W. Koch, B.S., Assistant in Agricultural Extension.

* Resigned. † Leave of absence.

James Koeber, B.S., Instructor in Agricultural Engineering, Davis.
E. J. Lea, M.S., Associate Professor of Nutrition.
L. Y. Leonard, M.S., Instructor in Agricultural Extension.
C. B. Lipman, Ph.D., Professor of Plant Nutrition.
W. E. Lloyd, B.S., Assistant Professor of Poultry Husbandry, Davis.
J. W. Logan, D.V.M., Specialist in Agriculture.
J. D. Long, B.S., Assistant in Agricultural Engineering, Davis.
R. D. McCallum, B.S., Instructor in Agricultural Extension.
Anne E. McCormick, B.S., Assistant in Agricultural Extension.
J. Q. McDonald, B.S., Assistant in Agricultural Extension.
E. G. McKibben, B.S., Assistant in Agricultural Extension.
W. W. Mackie, M.S., Assistant Professor of Agronomy.
B. A. Madson, B.S.A., Assistant Professor of Agronomy.
J. C. Martin, B.S., Instructor in Plant Nutrition.
T. C. Mayhew, B.S., Specialist in Agricultural Extension.
Elwood Mead, D.E., Professor of Rural Institutions.
R. F. Mead, M.S., Assistant in Animal Husbandry, Davis.
Grant Merrill, B.S., Assistant in Agricultural Extension.
Woodbridge Metcalf, M.S., Associate Professor of Forestry.
Orpha A. Miller, A.B., Assistant in Agricultural Extension.
R. F. Miller, M.S., Associate Professor of Animal Husbandry, Davis.
J. W. Mills, Specialist in Agricultural Extension.
Zilla E. Mills, Assistant in Agricultural Extension.
T. O. Morrison, B.S., Specialist in Agricultural Extension.
B. D. Moses, B.S., Assistant Professor of Agricultural Engineering, Davis.
C. S. Mudge, Ph.D., Assistant Professor of Dairy Industry, Davis.
Walter Mulford, F.E., Professor of Forestry.
F. T. Murphy, B.S., Assistant in Agricultural Extension.
C. S. Myszka, M.S., Assistant Professor of Agricultural Extension.
N. A. Negley, M.S., Specialist in Agricultural Extension.
J. W. Nelson, B.S., Associate Professor of Agricultural Extension.
Gladys Nevenzel, Assistant in Agricultural Extension.
W. E. Newlon, B.S., Specialist in Agricultural Extension.
W. D. Norton, B.S., Specialist in Agricultural Extension.
*E. D. O'Brien, Assistant in Agricultural Extension.
E. L. Overholser, M.A., Assistant Professor of Pomology.
H. E. Paxton, B.S., Assistant in Agricultural Extension.
Pearl Pemberton, M.A., Assistant in Agricultural Extension.
G. L. Philp, M.S., Instructor in Pomology, Davis.
C. A. Phillips, B.A., Instructor in Dairy Industry, Davis.
Mrs. Margaret E. Plimpton, Assistant in Agricultural Extension.
Anna L. Polak, A.B., Assistant in Agricultural Extension.
J. L. Quail, B.S., Assistant in Agricultural Extension.
H. J. Quayle, M.S., Professor of Entomology in Citrus Experiment Station and Graduate School of Tropical Agriculture, Riverside.
L. A. Raffetto, B.S., Assistant in Dairy Industry, Davis.
W. R. Ralston, B.S., Specialist in Agricultural Extension.
H. S. Reed, Ph.D., Professor of Plant Physiology in Citrus Experiment Station and Graduate School of Tropical Agriculture, Riverside.
W. M. Regan, A.M., Associate Professor of Animal Husbandry, Davis.
M. A. Rice, B.S., Specialist in Agricultural Extension.
Mary M. Richardson, Assistant in Agricultural Extension.
C. L. Roadhouse, D.V.M., Professor of Dairy Industry, Davis.
W. W. Robbins, Ph.D., Associate Professor of Botany, Davis.
R. T. Robinson, Specialist in Agricultural Extension.
*P. F. Roller, A.B., Assistant in English, Davis.
J. T. Rosa, Ph.D., Assistant Professor of Truck Crops, Davis.
C. W. Rubel, B.S.A., Associate Professor of Agricultural Extension.
B. A. Rudolph, M.S., Research Associate in Plant Pathology, Mountain View.
K. A. Ryerson, B.S., Assistant in Agricultural Extension.
A. W. Sampson, Ph.D., Associate Professor of Forestry.

* Resigned.

E. D. Schlaman, B.S., Assistant in Agricultural Extension.
*Helen Schlesinger, M.A., Assistant in English, Davis.
W. R. Schoonover, M.S., Specialist in Agricultural Extension.
F. X. Schumacher, B.S., Assistant in Forestry.
Bertha R. Schwab, B.S., Assistant in Agricultural Extension.
*A. F. Scott, B.S., Assistant in Agricultural Extension.
May Secrest, B.S., Assistant Professor of Agricultural Extension.
E. F. Serr, B.S., Assistant in Agricultural Extension.
H. H. Severin, Ph.D., Instructor in Entomology.
C. F. Shaw, B.S., Professor of Soil Technology.
S. W. Shear, M.S., Associate in Rural Institutions.
H. W. Shepherd, B.S., Instructor in Landscape Gardening, Davis.
Alfred Smith, M.A., Assistant Professor of Soil Technology, Davis.
C. O. Smith, M.S., Research Associate in Plant Pathology, Riverside.
D. M. Smith, B.S., Assistant in Agricultural Extension.
Elizabeth H. Smith, M.S., Assistant Professor of Plant Pathology.
Fleda E. Smith, B.S., Assistant in Agricultural Extension.
L. B. Smith, B.S., Instructor in Agricultural Extension.
R. E. Smith, B.S., Professor of Plant Pathology.
F. M. Spurrier, B.S., Assistant in Agricultural Extension.
J. L. Stahl, B.S., Associate in Pomology, Davis.
E. L. Stanley, B.S., Assistant in Agricultural Extension.
C. C. Staunton, Specialist in Agricultural Extension.
Olive E. Steinbeck, B.L., Assistant in Agricultural Extension.
E. J. Stirniman, M.S., Specialist in Agricultural Extension.
R. E. Storie, B.S., Assistant in Soil Technology, Davis.
C. E. Sullivan, B.S., Specialist in Agricultural Extension.
Wallace Sullivan, B.S.A., Specialist in Agricultural Extension.
G. J. Surr, Field Assistant in Citrus Experiment Station, Riverside.
Parker Talbot, B.S., Assistant Professor of Agricultural Extension.
A. A. Tavernetti, B.S., Assistant in Agricultural Extension.
T. F. Tavernetti, B.S., Assistant to Director of the Branch of the College of Agriculture at Davis, Assistant Professor of Farm Practice.
L. W. Taylor, B.S., Assistant in Agricultural Extension.
C. E. Tegner, B.S., Assistant in Dairy Industry, Davis.
*B. H. Thomas, B.S., Assistant in Animal Husbandry, Davis.
E. E. Thomas, B.S., Research Associate in Agricultural Chemistry in Citrus Experiment Station and Graduate School of Tropical Agriculture, Riverside.
*R. R. Thomson, B.S., Assistant Professor of Agricultural Engineering, Davis.
J. E. Tippett, B.S., Specialist in Agricultural Extension.
W. J. Tocher, B.S., Assistant in Agricultural Extension.
C. M. Titus, M.A., Assistant Professor of Irrigation Investigations and Practice, Davis.
W. E. Tomson, B.S., Associate in Animal Husbandry, Davis.
Enoch Torpen, B.S., Assistant in Agricultural Extension.
*I. F. Torrey, B.S., Associate in Chemistry, Davis.
†Jacob Traum, D.V.M., Associate Professor of Veterinary Science.
G. H. True, B.S., Professor of Animal Husbandry, Davis.
W. P. Tufts, M.S., Assistant Professor of Pomology, Davis.
G. D. Turnbow, M.S., Assistant Professor of Dairy Industry, Davis.
R. S. Vaile, B.A., Assistant Professor of Orchard Practice in Citrus Experiment Station and Graduate School of Tropical Agriculture, Riverside.
E. C. Van Dyke, M.D., Associate Professor of Entomology.
†H. E. Van Norman, B.S., Professor of Dairy Management, Davis.
G. H. Vansell, A.M., Instructor in Entomology, Davis.
F. J. Veihmeyer, C.E., Assistant Professor of Irrigation Investigations and Practice, Davis.
E. C. Voorhies, B.S., Assistant Professor of Animal Husbandry, Assistant to the Dean.
W. G. Waterhouse, B.S., Assistant in Agricultural Extension.
H. A. Wadsworth, B.S., Instructor in Irrigation Investigations and Practice, Davis.
H. E. Wahlberg, B.S., Specialist in Agricultural Extension.
H. L. Washburn, B.S., Specialist in Agricultural Extension.

* Resigned. † Leave of absence.

H. J. WEBBER, Ph.D., Professor of Sub-Tropical Horticulture, Director of Citrus Experiment Station and Graduate School of Tropical Agriculture.
H. A. WEINLAND, B.S., Assistant Professor of Agricultural Extension.
W. W. WEIR, Assistant Professor of Soil Technology.
*CAROLYN F. WETZEL, Assistant in Agricultural Extension.
E. J. WICKSON, M.A., Professor of Horticulture, Emeritus.
H. J. WILDER, A.B., Specialist in Agricultural Extension.
P. S. WILLIAMSON, B.S., Assistant in Agricultural Extension.
ELIZABETH M. WILLS, B.L., Assistant in Agricultural Extension.
J. F. WILSON, M.A., Assistant Professor of Animal Husbandry, Davis.
MARYETTA WILSON, B.S., Assistant in Agricultural Extension.
C. K. WINDERMUTH, B.S., Assistant in Agricultural Extension.
A. J. WINKLER, Ph.D., Associate in Viticulture, Davis.
M. M. WINSLOW, B.S.A., Specialist in Agricultural Extension.
E. V. WINTERER, M.S., Assistant in Soil Technology.
‡F. W. WOLL, Ph.D., Professor of Animal Nutrition.
†C. W. WOODWORTH, M.S., Professor of Entomology.
*Mrs. M. H. WOODWORTH, Specialist in Agricultural Extension.
*R. V. WRIGHT, B.S., Specialist in Agricultural Extension.
W. L. ZINK, B.S., Assistant in Agricultural Engineering, Davis.

---

* Resigned. † Leave of absence.

REPORT OF THE DEAN OF THE COLLEGE OF AGRICULTURE

BERKELEY, CALIFORNIA, June 30, 1923.

To the President of the University of California:

You will find, herewith, the Annual Report of the College of Agriculture, including the Agricultural Experiment Station and the Agricultural Extension Service of the University of California, for the fiscal year ended June 30, 1923. It embodies the results of work during the year in the various divisions of the College of Agriculture and includes reports by C. M. Haring, Director of the Agricultural Experiment Station, E. C. Voorhies, Acting Director of Resident Instruction, and B. H. Crocheron, Director of Agricultural Extension.

In addition to the large amount of data presented herewith relative to activities and results of the College and Station, further results will be found in Technical Papers 1 to 7, in Bulletins 346 to 367, in Circulars 250 to 267, and in the 350 articles by various members of the staff, appearing in scientific and other publications during the year.

THE AIM OF THE COLLEGE OF AGRICULTURE

The problem of the College of Agriculture is to increase the public welfare through the aid given to the industry of agriculture. The purpose is not merely to find the most economical means of producing food, clothing, and shelter, to produce more, or to produce a given quantity with less human effort, but also to keep the industry attractive to those engaged in it and to maintain a citizenship in the open country which, as in the past, shall be self-reliant, intelligent, and progressive. The efficiency of the College of Agriculture during the past decade must be judged from all of these viewpoints.

The University of California, including its College of Agriculture, is an instrument only. It is not an end in itself. The value of an instrument does not necessarily depend upon its perfection but upon the way it is operated. When a husband writes that his family life has been made more satisfactory through the College, that is an end result. It is an important antecedent to the success of an organization to determine whether its aim is correct.

It is intended in the following paragraphs to describe the machinery of the College of Agriculture, and to discuss the various methods by which it functions as well as the results obtained.

The Way It Functions

It perhaps cannot be repeated too often that the chief functions of the College are investigation and teaching. In the Annual Report of the Dean for the year ended June 30, 1914, the purpose of the College, which has since guided its activities, were expressed as follows:

"The founders of the Smithsonian Institution established at Washington, D. C., in 1846, declared their purpose to be the creation and diffusion of knowledge. It was not to be judicial, legislative, nor executive. Thus a new function of national import was created. In like manner it is the purpose of the Department of Agriculture of the University of California to discover and instruct, but not to control nor direct. The Department seeks to find the truth as it relates to agricultural methods and processes and by various means of education to instruct as many persons as possible in the results of research obtained by this and other agricultural experiment stations."

Legal Requirements

While the function of the College of Agriculture is confined chiefly to the creation and diffusion of knowledge, the activities of the College are still further limited by law to certain fields of knowledge. Furthermore, Federal appropriations specifically require certain instrumentalities.

The first Morrill Act (1862) requires that institutions created under this Act shall be colleges, that is to say, they must give instruction recognized as of college grade. In 1862, the term "college" had a definite meaning.

The second Morrill Act (1890) provides that money arising under this Act is "to be applied only to instruction in Agriculture, Mechanic Arts, the English language, and the various branches of Mathematics, Physics, natural and economic sciences with special reference to their application in the industry of life and to the facilities for such instruction." The debates in and out of Congress at the time show the importance that was attached to this wording, at least in the minds of the proponents of the Act.

The Nelson Amendment (1907) appropriating additional funds, declares that "Colleges may use a portion of this money for providing courses for the special preparation of instructors for teaching the elements of agriculture and mechanic arts."

The Hatch Act (1887) creating the Agricultural Experiment Stations, states their duty to be "to conduct original researches or verify experiments on the physiology of plants and animals; the diseases to which they are severally subject, with the remedies for the same; the chemical composition of useful plants at their different stages of growth; the comparative advantages of rotative cropping as pursued under the varying series of crops; the capacity of new plants or trees for acclimation; the analysis of soils and water; the

Fig. 1.—Agriculture Hall, dedicated November 20, 1912; cost including equipment $200,000. Contains the offices of the Dean and Director, the Divisions of Agricultural Extension, Entomology, Landscape Gardening, Plant Pathology, and Rural Institutions, and the Department of Irrigation. See University of California Chronicle, vol. XV, no. 1 (Jan., 1913).

chemical composition of manures, natural or artificial, with experiments designed to test the comparative effects on crops of different kinds; the adaptation and value of grasses and forage plants; the composition and digestibility of the different kinds of food for domestic animals; the scientific and economic questions involved in the production of butter and cheese; and such other researches or experiments bearing directly on the agricultural industry of the United States as may in each case be deemed advisable, having due regard to the varying conditions and needs of the respective States and Territories.''

The Adams Act (1906) specifies that the additional appropriations are ''to be applied only to paying the necessary expenses of conducting original researches or experiments bearing directly on the agricultural industry of the United States, having due regard to the varying conditions and needs of the respective States or Territories.'' There has been considerable doubt expressed as to whether the funds under the Hatch and Adams Acts may be used to investigate certain important economic questions relating to agriculture.

The Smith Lever Act (1914) defines its aim to be ''to aid in diffusing among the people of the United States useful and practical information on subjects relating to agriculture and home economics and to encourage the application of the same.''

Thus the funds appropriated by the Federal Government must be carefully accounted for since (1) those arising from the Morrill Acts and the Nelson Amendment can be used only for resident instruction of a college grade; (2) those arising from the Hatch and Adams Acts for experiments bearing directly on the agricultural industry; while (3) those from the Smith Lever Act must be used for instruction and practical demonstrations to non-resident persons. Resident short courses are not provided for by any Federal appropriation. By a ruling of the U. S. Department of Agriculture the expense of correspondence courses in agriculture cannot be met out of Smith Lever funds. Fortunately the state appropriations are not restricted by similar requirements. As a result of these Federal Acts and the general experience of land grant colleges covering fifty years, three instrumentalities have come to be recognized, viz., investigation, resident teaching, and non-resident teaching or the Agriculture Extension Service.

Singleness of Purpose

In view of the broad scope of the work of the College on the one hand and the legal requirements on the other, it is not strange that questions and confusion of thought should arise concerning the organization and even concerning the purpose of the College. It is fairly obvious that the result to be striven for is a high civilization in the open country. The problem is ''to maintain the native values of rural life.'' Research and teaching (resident and non-resident) are means to the end.

The College of Agriculture is divided into about twenty subject-matter divisions. Each division has in the main, three functions:

research, resident instruction, and non-resident instruction. While no individual is obliged to fulfill all these functions some do, and many fulfill two of them very definitely. A member of the staff may teach five months in the year and devote six months to reseach. This often prevents the necessity of the duplication of men. In some cases it adds to the virility of the teaching. It makes more certain that the teaching is in accordance with the latest experimental evidence.

Fig. 2.—Chemistry Laboratory of the Citrus Experiment Station (Rubidoux), erected in 1913 at a cost of about $15,000. In the foreground is the experimental orchard of oranges and lemons planted in 1907.

It seems impracticable to make titles or privileges such as sabbatical leaves and pensions dependent upon the function performed. There appear also to be special reasons for recognizing men and women in the Agricultural Extension Service. There is no essential difference in principle between resident and non-resident instruction. It is desirable to emphasize the fact that Extension men are teachers and not police officers or commercial agents. But the most important reason is that Extension men must have some agency upon which to lean. If they are not permitted to feel that they are an integral part of the University, they will lean upon some other agency.

The fundamental aim of the College is to serve the people of the state in so far as it can be done through education and research. A divided household cannot do so effectively. If the whole enterprise is

not under a single unified administration its efficiency will be greatly reduced. This policy has been an important factor in whatever success the College of Agriculture may have had during the past decade.

It has been the policy of the College of Agriculture to impress every member of its staff with both its intramural and extramural responsibilities. All phases of its varied activities have been held to be equally necessary and important. Neither from the standpoint of the citizens of the state nor of the members of the staff has the College of Agriculture had any step-children.

The State Department of Agriculture

The College of Agriculture has been fortunate in obtaining always the most cordial coöperation of the State Department of Agriculture. The Director of the State Department and the Dean of the College have both recognized that these two institutions have separate functions. The State Department of Agriculture exercises executive and supervisory powers. The College of Agriculture devotes its energies to research and instruction. To make this distinction complete, the enforcement of the fertilizer control and the insecticide control acts was transferred to the State Department. The policy here enunciated has the approval of the Commission on Agricultural Education. The Commission reports that it found no better working arrangement in any state than the agreement formulated by the Director of the State Department of Agriculture and the Dean of the College of Agriculture which is set forth below:

> The State Department of Agriculture should exercise executive and regulatory powers. The College of Agriculture should devote its energies to research and education, both resident and non-resident. It is not in the interest of the public welfare that it should be charged with police duties. It is the function of the executive branch of the state, whose head is the governor, to enforce the laws relating to agriculture through the director of agriculture and his subordinates, and those relating to forestry through the Commission of Forestry. The functions of the University, and hence of the College of Agriculture, are investigation and teaching. The College should not seek to control the action of any person. Its primary function is to determine the truth and state it accurately. The College should not have placed upon it any commercial, executive or police duties, nor should it be the policy of the state to appropriate money to the State Department of Agriculture for education or investigation, nor should it be the policy of the state to appropriate money to the College of Agriculture for regulatory purposes.

Fig. 3.—Class Room Building at the Branch of the College of Agriculture, Davis, for which the California Legislature in 1913 appropriated $65,000. Contains in addition to eight offices and seven class rooms, a library and an auditorium with a seating capacity of 550 persons.

Fig. 4.—Dining Hall at the Branch of the College of Agriculture, Davis, completing the second unit for which the California Legislature in 1913 appropriated $10,000. The west end contains the Students' Infirmary. West Dormitory is seen beyond.

What Is a College of Agriculture?

The Encyclopedia Britannica defines agriculture as "the science, art and industry of utilizing the soil so as to produce the means of sustenance, embracing in its widest sense the rearing of livestock as well as the raising of crops." A briefer and yet even more comprehensive definition would be "Agriculture is the knowledge and practice of producing living things." Writers of more than one nation have expressed the view that agriculture is more than a science, more than an art, more than an industry; it is also a life. Just as there are aristocrats and plebeians, there are rural minded and urban minded people. Perhaps in agriculture more than in any other industry, one must deal with the home and community aspects of the people who are engaged in it.

While the so-called fundamental sciences as well as a great range of other knowledge, such as philosophy, mathematics, history, and economics, must be brought to bear on the industry of agriculture, a college of agriculture is not a college of science, any more than a college of engineering is a college of mathematics, no matter how heavily it may lean on science or mathematics in the solution of its problems. One of the greatest difficulties in the conduct of a virile agricultural experiment station is in maintaining a staff whose chief interest is in "conducting original research or experiments bearing directly upon the agricultural industry of the United States, having due regard to the varying conditions and needs of the respective states and territories," rather than in developing a particular field of inquiry as such. Both attitudes are of course important. It is rather a question of where the emphasis is to be placed by those who are connected with a college of agriculture.

Individuality of the Experiment Station

There has been much discussion concerning the importance of maintaining the individuality of the experiment station. A person will generally, although not always, accomplish most who at any given period of time devotes his energies mainly to one kind of service. The general point of view which has come to be accepted by a large number of the agricultural colleges of the country is best shown by the views of two college presidents. In 1919, President A. F. Woods of Maryland Agricultural College said at the thirty-third convention of the American Association of Agricultural Experiment Stations:

There are . . . . certain difficulties attending some types of organization that should be overcome or avoided. For example, a type of organization that permits the workers in any subject matter department to get out of touch with each other, leading to lack of cooperation and to duplication is destructive of morale, both within and without institutional walls. It wastes energy and money and accomplishes little. This danger appears to be greatest where the ideal teaching, extension and research functions are most distinctly separated, the subject matter men being responsible only to their respective directors or deans.

Fig. 5.—West Dormitory for which the California Legislature in 1913 appropriated $40,000, the third of three dormitories at the Branch of the College of Agriculture at Davis, which, combined, furnish housing capacity for 200 students.

At the same meeting under the heading, "The Necessity of Unity," President Peterson of the Utah Agricultural College, said:

The college programme in agriculture is essentially three phased:

1. Research.
2. Interior instruction.
3. Extension.

These three, however, constitute one attack upon the problems of rural civilization. They constitute a unit, not only from the standpoint of industrial and economic necessity, but furthermore, represent a practically ideal pedagogic arrangement.

No teaching is more spiritless than that which does not have access to original sources. So far from the head waters, it comes soon to a condition of stagnation. There is no constant replenishment of the water from fresh sources . . . . Therein lies one of the greatest weaknesses in many institutions which did not possess the stimulus to research and extension enjoyed by our institutions. The purely academic ingrows and destroys itself.

Policies in Locating Activities

The College of Agriculture of the University of California is like one of the jigsaw puzzles which are sometimes used to teach children geography. It is necessary to put the pieces together to see the map as a whole. In the case of the College this is impossible. Few persons, even members of the staff, have seen all its activities, and therefore do not acquire an adequate mental picture of its work. Owing to the well known variation in temperature, rainfall, soil and topography, the consequent large number of agricultural products and the high degree of specialization which has taken place in the growing, harvesting and marketing of agricultural commodities, the land, buildings, and activities of the College are widely distributed throughout the state. For this reason the material equipment of the College at any one place is not impressive. Visitors accustomed to the great buildings and laboratory equipment of agricultural colleges elsewhere in visiting a particular unit of the College are often disappointed with its slender appointments. While the equipment of the College of Agriculture when viewed as a whole is really good, it must be admitted that emphasis has been placed upon the excellence of the members of the staff rather than upon the quantity of the equipment.

In a state so large that counties become empires in themselves the policy surrounding the location of its activities becomes one of the most important questions with which administrative officers, as well as members of the Legislature, have to deal. Where an institution is supported from Federal and State appropriations, care must be taken to consider the national and state welfare rather than the regional interests.

There are sometimes vital reasons for the location of a unit in some particular region. For example, the location of a college in a large center of population enables students to attend college while living at home. There are certain advantages in students obtaining their college education away from home surroundings. A local institution may therefore be a disadvantage to some students. Other persons, however, for economic reasons would never receive a college education if it were not at their door. Sometimes the location of an institution or of a unit of an institution is merely actuated by pride of possession. Ruskin once said, ''Pride is at the bottom of all great mistakes.'' In other instances the location is dictated by no higher motive than the desire for increase in local business or in the price of real estate.

There are three possible reasons for the establishment of additional centers of instruction:

(*a*) The possibility of a more efficient instruction because of environmental conditions.

(*b*) Subdivision reduces the number of students in any unit.

(*c*) To enable students to receive instruction without the expense of being away from home.

The development of a system of education based upon other considerations is likely to involve the state in needless expenditure.

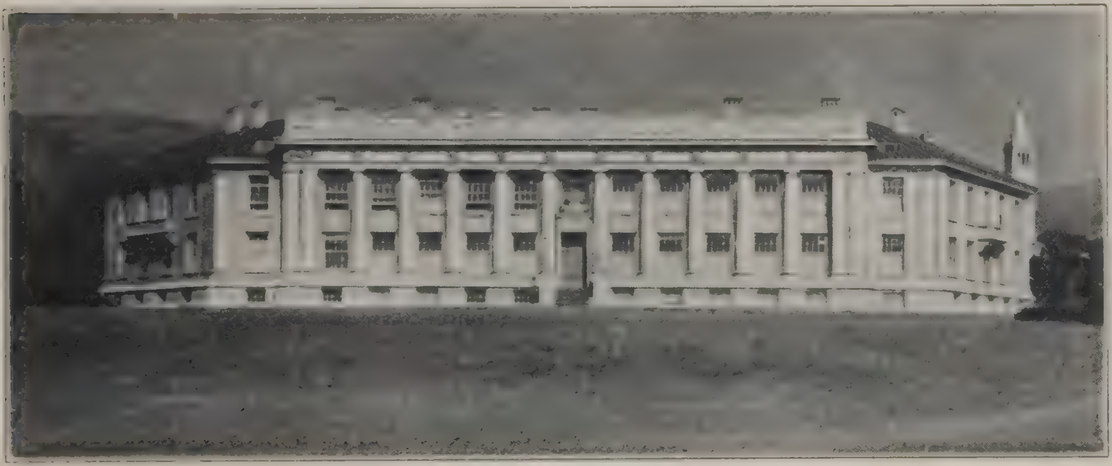


Fig. 6.—Hilgard Hall, dedicated October 13, 1917; cost with equipment $375,000. Erected from the $1,800,000 bond issue provided by the initiative vote of the people in 1914. Comprises the second of three buildings which will complete the agricultural quadrangle at Berkeley according to the Phoebe Hearst architectural plan for the development of the University. Consists of 111 rooms, devoted to offices, class rooms and laboratories, and houses in part the Divisions of Agriculture, Agronomy, Citriculture, Farm Management, Forestry, Genetics, Pomology, Soil Technology, and Viticulture and Fruit Products. See University of California Chronicle, vol. XX, no. 2 (April, 1919).

One of the greatest difficulties in developing a state system of education, and this applies particularly to the College of Agriculture, is the inability to think in terms of functions rather than in terms of geography. This is true not only of the citizens of the state but also of the administrative officers of the institution itself. Thus, for example, the units at Berkeley, Davis, and Riverside are each designed to perform the functions which their environment and other circumstances best fit them to perform. Each is part of a general programme. Standing alone, each is relatively unimportant, but as an integral part of the whole it helps to make the greatest agricultural college in the world. It is very important, therefore, that the several units of the College of Agriculture shall be developed from this viewpoint.

No additional units or activities should be developed from geographical motives. The purpose should be to serve the best interests of the Commonwealth as a whole.

The policy of the College of Agriculture has been to restrict the number of permanent units but to establish temporary centers of investigation where circumstances require, provided funds permit. Wherever such temporary establishments are required, it is good policy for the state to pay the salary and maintenance charges, requiring the local community to furnish land and buildings when such are required. The state should hesitate to acquire realty unless a permanent need is obvious, since such action is apt to lead through local pressure to additional expenditures not related to the original purpose. Requests, accompanied in some cases by long petitions of leading citizens, are frequently received. These petitions sometimes suggest no problem or group of problems. When problems are suggested they may be found to be under investigation at one or more of the existing stations. Owing to the great variety of climate, soil and crops, most localities do have local problems which often need intensive study. It has been the policy of the College of Agriculture to stand ready to study these problems whenever so directed and funds are made available, but the constant insistence upon the enlargement of the number of substations based upon geographic considerations is likely to lead to unwise expenditures.

Autonomy

In the summary of findings and recommendations of the Commission on Agricultural Education (1922) occurs the following:

> The commission recommends that the College of Agriculture be granted the largest measure of autonomy in educational matters compatible with the existence of a unified university policy, and that the decision as to the extent of this autonomy rest with the president and regents rather than with any academic body.

While not necessarily inconsistent with the above statement, it should be pointed out most emphatically that the College of Agriculture should not be given a degree of autonomy not enjoyed by other colleges of the University. The teaching of agriculture in land grant colleges is a basic requirement. The College of Agriculture should occupy the same status as other colleges, no more, no less. What is needed is a reorganization of the University by which each and every college should be given a greater opportunity to meet its particular problems. In place of the Academic Senate there should be created

Fig. 7.—Citrus Experiment Station and Graduate School of Tropical Agriculture at Riverside, California. On the right, main laboratory building; on the left, laboratory of Plant Pathology and Physiology; distant group of buildings in center, barns and ranch headquarters; background on the left, 80-acre experimental citrus grove planted in 1917. California Legislature in 1913 appropriated $125,000 for these buildings and the Director's residence. Dedicated March 27, 1918. See University of California Chronicle, vol. XX, no. 4 (Jan., 1918).

a body which, instead of determining its own membership, should consist of a limited number of persons selected by vote of the members of the several colleges. The membership of each college should be determined by the Regents upon the recommendation of the President. This body might well be known as the University Senate. The word "academic" is too restrictive, hence is misleading and harmful. The plan here outlined has been considered by the Policy Committee of the College of Agriculture and unanimously preferred to the plan of special autonomy, although many of the members of the College feel that if this is not possible, then autonomy for the College of Agriculture alone would be preferable to the continuance of existing conditions. I commend this problem to your careful consideration.

The Status of County Agents

In many states the county agents are also representatives of the counties or of the farmers' organizations and are appointed by them. These counties or farmers' organizations pay the larger part of the salaries of these county agents, and have, therefore, control over their appointment. The college usually submits a list of recommended candidates to the county concerned but the appointments are made by and in the name of the local coöperating parties. It would not be desirable for the universities and colleges involved to give academic status or privilege to men whose appointments they do not initiate, determine, or terminate. It should be pointed out that members of the resident staff of the Agricultural Extension Service which often includes many Extension specialists, are generally members of the Agricultural faculty.

At the University of California, all salaries of all persons representing the college in any way are paid from funds under the direction of this institution. The farm advisors or county agents do not represent the counties or the farm bureaus, but are entirely appointed, paid, and supervised by the University. At the last convention of the Land Grant College Association, it was stated in an address by D. J. Crosby of Cornell University that thus far the only solution of the problem of maintaining county agents on a high plane was that offered by California, where the agents were given academic privileges, including sabbatical leave.

Be that as it may, these policies, now widely approved, have been largely responsible for whatever success the Agricultural Extension Service has attained in California. If this system is disrupted, the

College of Agriculture will begin to disintegrate; the efficiency of the farm advisors will decline, and the usefulness of the College of Agriculture will lessen.

The matter of titles for Agricultural Extension agents has been in a chaotic condition for some years and even the question of pensions and sabbatical leave are uncertain. Some county agents have academic titles and some do not. One of the county agents is now on sabbatical leave, but whether others who do not have academic titles are entitled to this privilege is uncertain. All Extension agents of a certain rank should be members of the Agricultural faculty. Whether they should be members of a general University body is less important. If a University Senate existed whose membership was composed as recommended under the paragraph on "Autonomy," the Agricultural faculty would from time to time determine by whom it should be represented.

No justification can be found for eliminating members of the Agricultural Extension Service from the operation of the rules regarding sabbatical leave and pensions. Any attempt to deal with the members of the Agricultural faculty, except on the basis of unity and equality, raises many difficulties. For example, of the graduates of the College of Agriculture at any particular commencement, four may take up work in the Agricultural Extension Service, one may enter the Division of Animal Husbandry, and another the Division of Pomology. All have had the same training and are substantially alike in ability. Without a unified programme, they have different privileges and a different outlook. The Division of Animal Husbandry or of Pomology may assign its new assistant to responsibilities for Extension activities and yet he would bear a different relation to the College than if he were an Extension specialist formally attached to the Agricultural Extension Division.

The head of a division charged with larger responsibilities for research and some teaching may elect to give a larger part of his personal time to the Agricultural Extension Service. Yet, he would have a different status from a man of equal length of service, experience, and ability who may be connected with the Agricultural Extension Service. The ultimate aim of the College of Agriculture makes it impossible to put men into pigeon holes and keep them there.

I cannot too strongly urge that this matter of titles and privileges for Agricultural Extension agents be reviewed at an early date.

The Scientific Method

There are certain fields of knowledge, such as chemistry, physics, geology, in which certain natural phenomena have been so accurately classified and systematized that they are referred to as "The Sciences." Workers in these restricted fields are called scientists. Sometimes they are disposed to deny that workers in other fields employ the scientific method. They have not yet arrived at that state of mind to which Sir Arthur Quiller-Couch refers when he writes: "I hold there is no surer sign of intellectual ill-breeding than to speak, even to feel, slightingly of any knowledge oneself does not happen to possess."

The processes by which the so-called sciences have been developed can be and are applied to other fields of inquiry. It is a question of accurate determination and correct deduction. There is always danger, as has been charged, that "They miss the evidence because they are so busy with a theory." The scientific method is not confined to the use of test tubes and reagents. It is certainly the duty of workers who use macroscopic materials to make sure that their methods will stand the closest scrutiny as to accuracy. Many times this has not been done.

Precision is, perhaps, more difficult, at least more expensive where pounds or bushels rather than milligrams are used. It is more difficult and more expensive to determine the reaction of cattle to certain nutritive substances than it is in the case of rats or other small animals, but when carried out with sufficient refinement of methods, the lessons gained may be equally important. It cannot be assumed that data obtained with one class of animals indicates the reactions that will be obtained with another class.

It is of prime importance to understand the fundamental principles governing the growth of plants. It is, also, important to make plants grow. Much necessary data can be obtained from pot experiments with plants, but field crops have a discouraging way of paying no attention to these findings. It has frequently been remarked that when the cow and the chemist disagree one should stick to the cow. The ideal would be to have them agree. In Agriculture, particularly, correct answers and sound conceptions are generally obtained only after using all methods and agencies available.

The Need of Good Teachers

A satisfactory solution of the problems of the College of Agriculture requires the maintenance of a proper perspective, of a suitable balance between:

(1) The discovery of new truths.

(2) The training of men to carry on the industry in all of its ramifications.

(3) The furnishing of information to those on the land and assistance in organizing for their economic and social needs.

The roof and the foundation are equally necessary to a complete house. An analysis of the budget for the year ending June 30, 1922, shows that about one-fourth of the income of the College was spent in resident instruction, the balance being about equally divided between experiment work and Agricultural Extension Service.

Fig. 8.—Horticulture Hall, dedicated October 24, 1922; cost with equipment $100,000. Part of the $400,500 appropriated by the California Legislature of 1921 for buildings and equipment at the Branch of the College of Agriculture, Davis. The second story rooms are offices and research laboratories. The first floor is given up to student lecture rooms and laboratories. Houses the divisions of Botany, Pomology, and Viticulture. At the left is an auditorium with a seating capacity for about 300 people and with facilities for exhibiting equipment, such as power sprayers and tractors. See President's Annual Report for 1923.

In the Annual Report of the Dean of the College of Agriculture for the year ending June 30, 1914, occur the following statements:

> It must be obvious to a thoughtful person that the research work of the Department of Agriculture of the University of California is fundamental to its success. Without accurate knowledge it is impossible to instruct or to advise properly. There is no warrant for an Extension Division or for a Farm Advisor unless the Experiment Station, through painstaking investigations, has created knowledge that is worthy of credence. There are only two satisfactory reasons for the maintenance of an Experiment Station by the nation and the state: one is that it shall extend the realm of knowledge concerning agriculture, the other is that those who investigate shall have no motive to do other than discover and state the truth. The highest quality an investigator can have is the ability to be judicial. The value of the man of research to the public does not lie so much in the special technical knowledge which he possesses as in the fact that his own welfare is in no way affected by the conclusions which he reaches. . . . The Director of the Station appreciates that if he fails to realize the fundamental requirements of men of research or fails to protect them in the quiet and orderly transaction of their tasks, he will fail in his full duty to the cause of agricultural progress in California.

The staff of the College has generally been more jealous of its research activities than of its other responsibilities; more conscious of its shortcomings in this direction and more active in extending its investigations than in striving to improve its methods of teaching. Whatever criticism, moreover, there may have been concerning the work of the College has been chiefly directed towards the resident instruction. The number of students can be counted; comparisons can easily be made between character and quality of the instruction in different institutions, between different colleges of the same institution, or between different divisions of the same college. In the opinion of the staff its investigational work is less adequate in proportion to the importance of the agricultural problems of California than is its teaching. Its resident teaching is probably as satisfactory as can be found in any similar college. Considering the complexities of the industry, no student interested in agriculture can find elsewhere a programme better suited to his needs.

Be that as it may, during the past two years much constructive thought has been given to the content of courses of study and to their methods of presentation. The best results can be obtained only when members of the staff are rewarded in title and compensation in accordance with their efficiency. If promotions are made to depend primarily upon published researches instead of upon the ability as a teacher, or the reverse, the efficiency of one or the other will decline. Probably not enough regard has been given to the good teacher.

a
b
c

Fig. 9.—Rooms in the Horticulture Building, dedicated October 21, 1922, at the Branch of the College of Agriculture, Davis.

a. Plate glass display cases in the main lobby on the first floor. The fruit specimens in the show cases are true-to-life wax models of various varieties of apples and pears. They are hand painted to give the exact natural coloring.

b. Research laboratory for advanced students and members of the Pomology staff.

c. A corner in one of the five research laboratories.

The Purpose of College Land

In every agricultural college in the world, the larger part of the instruction given to students is done *under cover*. After fifty years of experience in developing methods of teaching agriculture in the United States, it will be found that the number of hours of outdoor instruction given to agricultural students is limited. The hours of instruction are probably less than that given to engineering students. The reason for this must be obvious to anyone who has any knowledge of the requirements of methodical training and the necessity of a working schedule. This College of Agriculture has worked out a system of summer practice courses by which a considerable amount of outdoor instruction is given.

The chief uses to which land is put by agricultural colleges are:

1. Field investigations.
2. The production of specimens to be used by indoor laboratories.
3. The production of crops as food for livestock.

The climatic conditions which make Berkeley without a rival as a place for all-the-year-round study limits the extent to which land may be profitably employed for field investigations. Much valuable use can be made of a limited area for preliminary studies, but field trials made at Berkeley are not even applicable to the coast counties in many instances, much less to the interior valleys or to southern California. In view of the varied conditions of climate, soil, and industry in California, it has been found necessary to have areas on which field trials can be made in the environment in which the lessons taught by such trials are to be put to use. The University has been fortunate in acquiring several tracts for this purpose as outlined below.

Land Holdings

The land available for the use of the College of Agriculture is in the aggregate extensive, as is shown by the following memoranda concerning the partial holdings of the University of California:

Berkeley.—Through Acts of the Legislature, first in 1866 and again in 1868, the University of California was located in Berkeley, where it now possesses 417 acres of land. The eastern portion of this area, about 260 acres, has been used as a foothill pasture in connection with investigations by the Division of Veterinary Science on bovine tuberculosis, contagious abortion, and other diseases of domestic animals. Here was developed one of the first certified

FRITZ WILHELM WOLL

Born Bergen, Norway, May [illegible], 1863. B.S., Royal Frederik's University, Christiania, Norway, 1882; Ph.B., 1883; M.S., University of Wisconsin, 1886; Ph.D., 1904. Second Assistant Chemist, 1887, Assistant Chemist, 1890, Chemist, 1897–1913, Wisconsin Agricultural Experiment Station; Assistant Professor, 1893–1904. Associate Professor, 1904–06, Professor of Agricultural Chemistry, 1906–13, University of Wisconsin; Professor of Animal Nutrition, 1913–22, University of California; Chairman, Agricultural Experiment Station Editorial Committee, 1918–22. Author of textbooks and other publications on dairy practice and feeding; translator of Swedish works on dairying; contributor to technical publications and agricultural journals; visited Scandinavia for the United States Department of Agriculture, 1896; represented the University of Wisconsin at the Centennial Celebration of the University of Christiania, 1911; Fellow, American Association for the Advancement of Science. Member, Wisconsin Academy of Sciences, Arts and Letters, Society for the Promotion of Agricultural Science, and the Association of Official Agricultural Chemists (President, 1910–11); Member, International Jury, Panama Pacific International Exposition, 1915. Died December 5, 1922.

milk dairies in California. Here was prepared the first hog cholera serum in the State, the distribution of which has done so much to control cholera in hogs. Here chickenpox virus, which is now widely employed by poultry raisers, was originated and developed.

At the west end of the University Campus lies an area of about 30 acres, which for about fifty years was used by the College of Agriculture. Here Hilgard started the first field experiments on the depth of cultivation. Reports indicate that there had been previously considerable plantings on the campus under general University auspices, chiefly for landscape effect but with due regard to the possible usefulness of the trees and shrubs to the State in general.

In 1879 a garden of economic plants was established near the Center street entrance to the campus, where, in addition to hundreds of cereals and other annuals, "there were 55 plots of grasses, 25 of leguminous forage plants, 8 textile plants, 24 aromatic herbs, 59 of medicinal herbs, and 41 of miscellaneous plants." Wickson reports that "from 1880 onward for twenty years the garden of economic plants was the great show place of the Agricultural Department and it was maintained with great neatness and cultural excellence, with all the small plots of plants accurately labeled." Annually between 1880 and 1908, plants and seeds were distributed from this garden.

For many years an orchard existed on the northwest corner of the campus, a portion being on the site of the present group of Agricultural buildings. Wickson reports that "In 1889 buds were taken from this 'Standard Orchard' to propagate trees to plant at the 'outlying stations' established in 1890 and the old trees were also used to a considerable extent as a source of scions which were distributed to growers in various parts of the State. . . ." In 1895 the trees were removed since it was found that the environment was not highly suitable for the growth of fruit trees. The area continued to be used by the College of Agriculture until 1918 when it was required as a location for military barracks by the United States. After these structures were removed, the land was graded to conform to the landscape plans of the campus and has since been used for military drill and for recreational purposes. It was this incident which led to the discussion culminating in an Act of the recent Legislature making an appropriation for land and greenhouses as stated under "Greenhouses."

Davis.—In 1905, the California Legislature passed an Act requiring the purchase of a suitable tract of land for a University Farm of not less than 320 acres, one-half of which, at least, to be suitable for irrigation. This action resulted in the purchase in 1906 of 779 acres at Davis, Yolo County, at a cost of $103,290 which complied with the Act, viz: "It must be first-class tillable land, and in its soil, location, climate and general environment be typical and representative of the best general agricultural conditions in California, and be capable of successfully producing the general crops of the State, and as many as may be of all of the crops and products successfully grown in California." (For further discussion see paragraph entitled "Branch of the College of Agriculture at Davis.")

Riverside.—Through an Act of the California Legislature in 1905 a tract of about four acres was acquired near Mt. Rubidoux in Riverside, and a tract of about thirty acres adjoining was provided by the citizens of Riverside with a guarantee of occupancy free of charge for a period from 1907–1920. A laboratory was erected and in 1907 experimental orchards of oranges, lemons and

other fruits were planted in which studies of a most important character to the citrus industry and to soil management in general have been made. Through the California Legislature in 1913, a tract of 475 acres was purchased on the Box Springs road, three miles southeast of Riverside. In 1917, the Legislature again provided by the purchase of 300 acres, for a site for a "University Farm in Southern California" which was purchased adjacent to the Box Springs site as stated elsewhere. The University therefore owns in Riverside, aside from the Rubidoux site, a tract in one body of 775 acres, of which about 600 acres are tillable. On this area buildings have been erected and improvements made at a cost for land and improvements of about $400,000. The most extensive experimental orchards to be found anywhere have been planted. A staff of fifteen to twenty trained specialists are maintained at the Citrus Experiment Station, requiring a budget of about $150,000 annually. It is perhaps the most unique agricultural research institution to be found on the American continent.

Whittier.—In the same year (1905) that the California Legislature provided for the purchase of the University Farm at Davis and the Citrus Experiment Station which was established at Rubidoux, Riverside, it also made provision for the establishment of the Plant Disease Laboratory at Whittier. By an action of the Board of Trade at Whittier, the Regents of the University acquired a suitable lot in the town of Whittier on which it established the Southern California Plant Pathological Laboratory. In 1914, the work of this laboratory was transferred and combined with the Citrus Experiment Station at Riverside. During the war, the building was used by the Red Cross. In 1920 it was placed at the disposal of the State Department of Agriculture for its work in the reproduction of parasites for the control of scale insects. On July 1, 1923, this activity will be transferred to the University of California by an Act (1923) of the Legislature in accordance with the recommendation of Director G. H. Hecke.

Meloland.—An Act of the Legislature, as stated elsewhere, provided for investigations into the "various difficulties and problems affecting the growing of crops" in the Imperial Valley, provided "the necessary land therefor is obtained without cost to the State." The Board of Supervisors of the Imperial Valley made provision for the purchase by the County of forty acres at Meloland, six miles east of El Centro. This area became available for the use of the College of Agriculture in 1910. Here trials with field crops and fruits have been conducted. (See paragraph on Imperial Valley Station.)

Mountain View.—In accordance with the policy of the Agricultural Experiment Stations to study problems in the environment in which the problems occur, a station was established at Mountain View, Santa Clara County, in 1920, for the study of the culture, pruning, pollenization, and diseases of deciduous fruits. Studies of an important character on the influence of cultivation on soil moisture and upon the brown rot of apricots have already been made. Studies on the oak fungus and management of old orchards are also in progress. The buildings and three-quarters of an acre of land adjacent are leased by the University.

Petaluma.—An Avian Laboratory for the study of poultry diseases has, also, been established at Petaluma on leased property.

Fresno.—The Kearney Estate, comprising 5400 acres, was bequeathed to the University of California in 1910 by M. Theodore Kearney. Certain outlying areas have since been sold, reducing the area to about 5000 acres. On this

estate vineyards, orchards, and alfalfa ranches are maintained by the Board of Regents, the profits in main having been used in assisting to meet the expenses of the College of Agriculture. The College of Agriculture has carried on investigations on field crops, grape growing, and drainage reclamation, using about 200 acres for these purposes.

Whitaker's Forest.—A forest of 320 acres near Badger, Tulare County, was deeded to the University on July 26, 1910, as a bequest from Horace Whitaker. The will states that the tract is to be used "for forestry investigation and research connected with that branch of instruction as taught in the University of California, and that it be preserved and continued as a park and pleasure resort for the people of the State of California." The tract contains an excellent forest of big trees (*Sequoia gigantea*) and associated species, typical of the southern Sierra. The Division of Forestry is using the area for a study of the development of big tree second-growth forests.

Fig. 10.—Dairy Industry Building, dedicated October 21, 1922; cost with equipment about $225,000. The California Legislature in 1917 appropriated $50,000 and in 1921, $400,500, for buildings and equipment at the Branch of the College of Agriculture, Davis. Contains nine offices, three class rooms and seven laboratories. See President's Annual Report for 1923.

Greenhouses

Considerable agitation was precipitated relative to the need of land at Berkeley for the use of the College of Agriculture by the final withdrawal of the land located west of Hilgard Hall, as related in another paragraph. Several members of the staff were much disturbed by the loss of this land. This led first to the consideration of large tracts of land necessarily located at some distance from the University campus. Wiser counsel, however, finally prevailed. Even

had the environmental conditions warranted, it was seen that this could not be valuable for instructional purposes to students otherwise engaged in study on the University campus. The outcome, therefore, of the purchase of such a tract widely removed from the main activities of the College of Agriculture would be the establishment of another unit with all the resulting overhead activities and expenses.

During the three years in which this discussion was in progress, it became more and more evident that while the climate could not be changed, the conditions so far as effective teaching and investigation of the College of Agriculture at Berkeley were concerned, could be greatly ameliorated by adequate greenhouses. On January 22, 1923, the Dean of the College received a petition signed by forty-two members of the staff who were giving instruction or conducting investigations at Berkeley, in which it was stated "We consider this (adequate greenhouses) to be a paramount need of the College of Agriculture at this time." The petitioners said in part:

Most of the students are pursuing their studies only during the period from August to May, when plants cannot for the most part be grown satisfactorily under outdoor conditions. The providing of suitable living plant material for class-room use is generally impossible at present. It is likewise impossible to use experimental methods of instruction with the living plants. The response of plants to changes in the important atmospheric and soil factors, the influence of temperature and light and mineral nutrients on development and fruiting, the principles and practices of propagation by seeds, cuttings and graftage, the cultural characteristics and control measures for insect and fungous pests, the methods and results of plant breeding, and other important aspects of agricultural plant industry, can neither be experimentally illustrated to the student nor their demonstration undertaken by the student himself. The instructional work for undergraduates involving the use of growing plants and the special studies of graduate students, whether carried on at Berkeley or elsewhere, during this period can be undertaken and developed only in well equipped greenhouses of ample size with accompanying garden and laboratory facilities.

As a consequence of the discussion of the need for land and greenhouses at Berkeley, Senate Bill No. 585 was passed by the recent Legislature and signed by the Governor, appropriating \$50,000 and an additional fund of \$50,000 "out of any moneys in the State Treasury after July 1, 1925 . . . . for the purchase of land near the grounds of the University of California at Berkeley and for the erection of greenhouses either on said land to be purchased, or on other lands of the University of California at Berkeley." In order to make these funds available the Regents of the University of California must "file with the State Comptroller a certificate . . . . stating that it has in its hands the sum of at least \$50,000 in addition to the moneys hereby appropriated."

I strongly recommend that the greenhouses be erected on the University campus within at most five minutes' walk of Agriculture Hall. Doubtless future legislatures will make additional appropriations until the College of Agriculture will have adequate areas under glass. In view of the quantity of land already belonging to the University and now used by the College of Agriculture for its activities in various parts of the state the expenditure necessary for ten acres of greenhouses at Berkeley would do more to further research and instruction in agriculture than would the expenditure of a similar sum for further areas of land.

Fig. 11.—The Dairy Manufacturing Laboratory in the new Dairy Building. Consists of five departments: cheese, butter, ice cream, milk condensing, and market milk. Three large cheese vats are shown in the foreground. The curd in vat "A" will be made into cheddar cheese. Vat "B" contains skim milk which will be made into cottage cheese. The vertical cheese press "C" is used for making three pound "Junior" cheddar cheese. Only part of the horizontal cheese press "D," used for twenty two pound "Flats," is shown in the picture. Cream from the pasteurizer "E" is churned in the large barrel type churn "F." A great deal of sanitary piping is used in conveying the milk. This is washed in a galvanized iron tray, "G." The forewarmer "H" heats milk for separation by the flash method. Cream from the separator "I," to be used for market cream, runs directly to the jacketed type pasteurizer "J." All of the milk is received in a separate room and passes into the manufacturing room by gravity through the sanitary piping "K." The milk for bottling is drawn by vacuum into the glass enameled pasteurizer "L," from which it runs by gravity through the tubular drum coolers, "M," to the automatic bottling and capping machine, "N."

The Status of the Branch Units

There are many difficulties in the conduct of divided activities such as now exist in this College, having important portions of its work at Berkeley, Davis, and Riverside. Some of these difficulties are mechanical. They relate to space and time. Delays occur in administration and management—hence loss of efficiency. Some of these difficulties are financial: overhead expenses are increased; certain facilities must be duplicated; other facilities cannot be afforded where numbers are divided. A university of 5000 men may afford a $250,000 gymnasium, while a school of 500 men may only afford a $10,000 one.

Some of the difficulties are psychological: divided activities cause a lack of understanding and appreciation of each other's work; small units suffer from lack of enthusiasm, or from lack of contact with other workers whose knowledge may be helpful. Nevertheless, I believe that some of the difficulties now felt by the College of Agriculture on account of the location of its several units will disappear with the growth of the institution. When the College has 2000 students, 1000, say, in Berkeley and 1000 at Davis, perhaps many of the difficulties now seemingly great will not be felt. Assuming a sufficient number of students and the ability of administrative officers and instructors to think in terms of function instead of geography, these units would make possible a more efficient college than has yet been created in any state.

Branch of the College of Agriculture at Davis

According to an Act approved March 18, 1905, the University Farm was purchased at Davis, Yolo County, and in 1908 instruction was begun. In addition to the non-degree courses formerly known as the University Farm School, discussed elsewhere, the activities conducted by the College of Agriculture at the University Farm have consisted of (1) investigations by certain divisions such as Agronomy, Pomology, Viticulture, Animal Husbandry, Poultry Husbandry, and Dairy Industry; (2) upper division courses taken by students of the College of Agriculture of Berkeley for one or more semesters; and (3) short courses in agriculture intended primarily for persons of mature years.

The Act provided that

> Instruction shall be conducted in connection with and as a part of the College of Agriculture of the University of California, provision being made by the Regents for such attendance on the Farm of the College students as

may be deemed necessary to the completion of their College courses. The University Farm and the instruction given thereon shall be so conducted as to meet the needs of persons who desire instruction in agriculture, horticulture, viticulture, animal husbandry, dairying, irrigation, and poultry raising, and to prepare them for the pursuit thereof. It is also to be used for experimental and investigational work in connection with the Agricultural Experiment Station of the University of California.

On January 16, 1921, the Regents passed the following resolution:

The Regents of the University of California declare it to be the policy of the University to center as far as practicable all higher instruction and research in agriculture at Berkeley, and with the exception of the College of Agriculture at Berkeley to confine agricultural instruction to freshman and sophomore years, which latter instruction the Regents are prepared to undertake at other places than Berkeley and especially at the Davis Farm School.

According to this resolution, freshman and sophomore instruction has been organized and was begun in August, 1922. At that time about one-half of the freshman class of the College of Agriculture entered at Davis and the other half at Berkeley. During the second

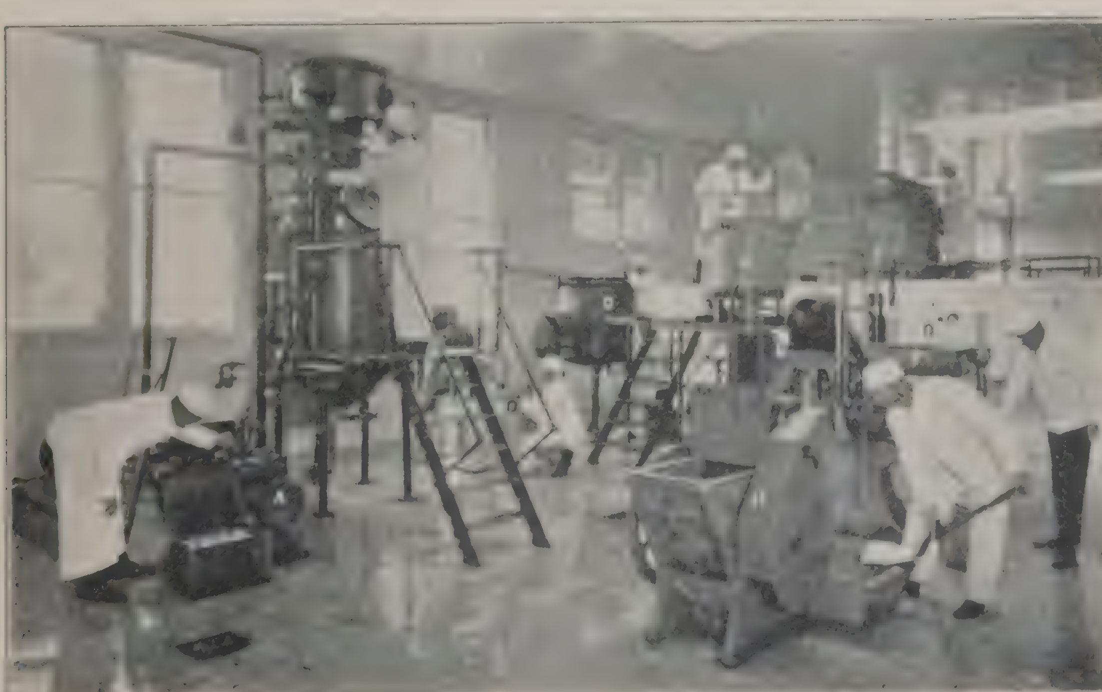


Fig. 12.—Ice Cream and Milk Condensing Laboratory in the new Dairy Building. This view shows the south end of the manufacturing wing. The condensing unit consists of a vacuum pump, "A," and a three-foot vacuum condensing pan, "B." The ingredients for the ice cream are mixed and pasteurized in the glass enameled vat "C." The mix then passes through the homogenizer "D," which forces it to the glass enameled holding vat "E" to be cooled and held until used. The mix flows by gravity to the 40-quart ice cream freezer "F." The upper part of an over run tester, "G," may be seen beyond the freezer. In the foreground is a motor driven ice breaker, "H." All of the equipment in the manufacturing department has the direct motor drive feature which eliminates overhead shafts and belts.

semester about one-half of all the students of the College were enrolled at the Branch. Of these, about one-half were non-degree students. The introduction of freshman and sophomore studies of university grade at the Branch of the College of Agriculture at Davis has therefore been successfully accomplished.

The transfer of students back and forth between Berkeley and Davis has been accepted by the students as a normal procedure. It helps to cement the Branch at Davis to the headquarters at Berkeley and also to emphasize in the minds of students the function of the Branch as a great outdoor laboratory for the College in such subjects as can be best studied there, rather than as a separate unit geographically.

The duplication of freshman and sophomore courses for University students is an interesting experiment in education. It is gratifying that it has made such an auspicious beginning, but this is not the chief value of the University Farm to the people of California. The most important uses of the University Farm at Davis are to furnish suitable opportunities for investigation of agricultural problems and to give instruction in junior and senior subjects which cannot be as well provided for at Berkeley or elsewhere.

When the time comes for further development of the College of Agriculture, as for example, in southern California, the need at the College for junior college work will not be so great as that for upper division and post-graduate work in those subjects which the environment and agricultural industries of the region make it possible to develop there better than elsewhere.

Women in Agriculture

The number of women studying agriculture, as might be expected, is not large. For several years about five per cent of the degree students in agriculture have been women. In 1922, 14 students in 148 who received degrees were women. Only one woman has taken the diploma in agriculture at the University Farm since its establishment in 1909, partly because in the earlier years adequate facilities were not provided for them. Dormitory facilities are now adequate for their accommodation and are under appropriate supervision. Every opportunity is afforded to young women to enter at Berkeley or Davis to study agriculture. They take part most enthusiastically in the social and other activities of the College.

This discussion concerning women in agriculture should not be confused with instruction in home economics which is now given at Berkeley. There is nothing in the environment of Davis nor in the character of the instruction which is given there or could be given that would lead to the conviction that home economics could be more efficiently taught at Davis than at Berkeley. On the contrary, Berkeley is not only an ideal environment for young women, but the institution offers a wealth of educational opportunities which is probably unexcelled anywhere. Instruction in home economics enables four thousand women who are specializing in other subjects to secure instruction in home economics if they choose to do so without making it their major interest. It would seem, therefore, a highly desirable fiscal policy to spend at Berkeley whatever money may be available for home economics.

a b c d

Fig. 13.—Laboratories in the Dairy Building, dedicated October 24, 1922, at the Branch of the College of Agriculture, Davis. See President's Annual Report for 1923.

a. Separator and Farm Dairy Laboratory. Students are given work in the operation and adjustment of cream separators. Small amounts of cream are churned in the hand-churns "A" and then the salt and moisture are worked into the butter, on the butter worker "B."

b. Dairy Testing Laboratory. Used to teach students the principles of dairying. Each student has a locker, "A," for glassware. The Babcock testers, "B," are mounted on concrete bases and the desk sinks, "C," and drains are lead-lined to prevent the action of acid.

c. The Bacteriology Laboratory. An abundance of north light enters the bay windows at the left and aids the students in the microscopic work and plate counting. Two large hot air sterilizers "A," and an electric oven, three Arnolds and one autoclave, offer ample facilities for thorough sterilization.

d. Dairy Research Laboratory. The Mojonnier Tester, "A," for making fat and solids determinations of dairy products plays an important part in the dairy laboratory because of its speed and accuracy.

Non-Degree Students

During the past decade there have been offered at the University Farm courses of study in agriculture and related branches to students who have reached college age but who do not necessarily have the requirements for admission to the University. Three groups of students have entered these courses: (1) persons eighteen years of age or over who have not had any high school education; (2) persons eighteen years of age or over who have been high school students but have not graduated; and (3) high school graduates either with or without the principal's recommendation.

During this period 2300 persons have received instruction in the non-degree courses, of which 553 have completed the courses and received the diploma. A large proportion of these men came from the cities; a considerable share of them are now operating farms. This has been the one opportunity in California for most of them to get some training for rural life. It is one of the important services which the College of Agriculture has rendered the state in recent years. Experience has shown that a large proportion of these young men desire, as nearly as their preparation and time will permit, the same instruction which has been found most satisfactory for degree students. Many of them come from the same high schools and even from the same families, have the same ambitions and the same outlook upon life. Of two brothers both graduates of the same high school, one may be a degree student, the other (not having received the principal's recommendation), a non-degree student. A certain percentage of the non-degree men, in some instances as high as 25 per cent, are found to be as good students as those in the degree courses, but in general, as might be expected, the graduates of high schools who do not have the principal's recommendation are not the equals of those so recommended. The most satisfactory students are the graduates of high schools with or without the principal's recommendation. The next most satisfactory are those who have never attended high school; while the least satisfactory are those that have been high school students but have not graduated.

It is a wise state policy to have students exhaust the local educational opportunities before going elsewhere. Since instruction in agriculture is now being generally introduced into the high schools, it may be found desirable in the future to restrict the non-degree students to graduates of high schools.

Fig. 14.—Recent additions or alterations at the Branch of the College of Agriculture, Davis.

a. Farm machinery sheds.

b. Model bunk houses for farm laborers on the left; dining hall for same on the right.

c. Agronomy Warehouse, equipped with modern machinery for cleaning cereals.

d. Old Creamery Building remodeled for divisions of Soil Technology and Irrigation Investigations and Practice.

e. Beef cattle feeding shed and pens.

f. Fruit packing house.

Branch of the College of Agriculture for Southern California

In 1919, the Legislature passed an Act requiring the Board of Regents to purchase a tract of land in Riverside County of not less than 300 acres for a university farm to be under the control and direction of the Regents of the University of California "in connection with and as a part of the College of Agriculture of the University of California," and requiring that provision be made "for such attendance on the farm of the College students as may be deemed best and necessary for the completion of their College courses." An appropriation was made for partial payment on the tract.

Acting under these instructions, the Regents purchased 300 acres adjacent to the Citrus Experiment Station. In 1921 the Legislature appropriated a sum sufficient to complete the payment on the tract and provided additional water supply, so that now the Citrus Experiment Station and the additional tract is assured an abundant supply of water of high quality.

No funds were provided for the improvement of the property or for the maintenance of instruction. Instead, the Legislature provided for the appointment by the Governor of a commission of five whose duties were "to make a thorough investigation of available sites in southern California upon which may be located an agricultural school or college" and to recommend "the type of institution that should be established thereon together with an estimate of the cost of the land, buildings, and the maintenance of such institution for the first four years of its existence."

Governor W. D. Stephens appointed the following members of the Commission: H. A. Jastro, chairman, S. C. Evans, Mark Grimes, G. H. Hecke, and Thomas F. Hunt. The Commission, after receiving offers of several properties and holding hearings, recommended that:

> the sum of forty thousand dollars ($40,000) be appropriated for such summer session courses as shall be deemed practical, to be held during twelve weeks, at Riverside, for the next two years, using the existing facilities of the Citrus Experiment Station and the staff of the College of Agriculture as far as practical and as determined by the College of Agriculture.

It has been found that the Intersession and the Summer Session courses given at Berkeley enable some students to complete their courses in three and one-half years and others who would have required four and a half years to do so in four years. It is believed that Intersession and Summer Session courses in sub-tropical fruits and related upper division subjects can be advantageously introduced

at Riverside, using to some extent the existing facilities of the Citrus Experiment Station. It was also the opinion of the Board that certain short courses, such as the six weeks' course in Poultry Husbandry could be advantageously offered at Riverside.

There was no direct action by the recent Legislature on the recommendations of the Board, but the Regents have approved the recommendation of the Finance Committee providing funds for the establishment of a six weeks' course in agriculture at Riverside. It is planned, therefore, to offer Intersession courses, beginning immediately after Commencement in 1924 and 1925. These courses are to be devoted to sub-tropical fruits and allied topics, such as soils, fertilizers, plant breeding, insect pests, and plant diseases. It is believed that this instruction will be found attractive, not only to students regularly enrolled in the College of Agriculture, but also to students of other colleges and universities in this and other states. Those not desiring credit could be admitted as auditors. Probably in time instruction will be expanded to twelve weeks, and similar provision may be made at Davis for summer session instruction in deciduous fruits, animal husbandry, and dairy industry. The College will then be on a three-semester basis, enabling students to get certain technical training without interfering with their programme at Berkeley.

The Demand for Agricultural Education

Discussing the enrollment in the agricultural colleges of the United States, the Commission on Agricultural Education observes:

> There is very evidently no great horde of eager young people clamoring for an opportunity to work out their destinies on the soil. Everywhere enrollment is lower than one would expect it to be in consideration of the character of the states in which the colleges are located. . . . Fortunately they [the agricultural colleges] have abundantly justified themselves in the influence they have exerted, but the disappointment of California at the comparatively small enrollment in its Agricultural College is shared by every state which the Commission visited, no matter what the type of its institution. The more the Commission studied this problem, the more it was convinced that the problem of increasing enrollment in agricultural colleges and keeping the boys on the farm is not to be solved by changes in curriculum, equipment, or method, but by the betterment of the social and economic conditions of rural life. No plan which leaves this out of major consideration is going to succeed in keeping farmers' sons in great numbers on the farm or in attracting the sons of city dwellers to it. This is the great work of the College of Agriculture today, and in it the University of California has no superior so far as we could find.

There can be no doubt of the general correctness of this admirable statement. It may be helpful to point out, however, that the enroll-

ment of agricultural students in the University of California warrants a hopeful attitude. In the data given below, the year 1922 has been chosen because it represents the maximum results yet attained, thus indicating the possibilities for agricultural education. In that year the University awarded 1116 degrees to men and 868 degrees to women. The number of men receiving degrees in Agriculture was 134; the number of women was 14. Twelve per cent, therefore, of the men receiving degrees were in Agriculture. As to be expected, the number of women was small. It so happens that in the year 1922 the College of Agriculture gave more degrees to men than any one of the other ten colleges of the University except the College of Letters and Science which is made up of a large number of separate departments.

In addition to the 134 degrees granted to students of Agriculture, the University also awarded 96 diplomas to men in the University Farm School (non-degree courses). Thus, in 1922, the University trained and sent into the world 1213 men of whom 230 or 18 per cent were in Agriculture. Although, because of the inclusion of the ninety-six Farm School students the quality is not strictly comparable, the proportion of men trained in Agriculture, more than one in six, may be considered not unsatisfactory.

These results do not warrant any spirit of boastfulness. The number of persons who study agriculture is small compared to the number of farmers, and does not meet the growing needs of the industry. Higher education in agriculture has only about fifty years of background to support it. Its chief development has occurred in the last twenty-five years.

The Imperial Valley Station

In 1908 the State Legislature appropriated the sum of $6000 to be expended "in the region known as the Imperial Valley and similar adjacent sections" for "the solution of various difficulties and problems affecting the growing of crops which have arisen in said region on account of the unique conditions obtaining in that portion of the state . . . ., providing the necessary land therefor is obtained without cost to the state." Subsequently the Board of Supervisors of Imperial County provided a forty-acre tract six miles east of El Centro. The average annual expenditure for the maintenance of this station during the past decade has been about $7000. This relatively small expense has been fully justified by the experimental results obtained and by the service which the station has been able to render to a region

which has "in common with other parts of the arid southwest the lowest rainfall and the lowest relative humidity, but also has a greater amount of sunshine and a greater number of clear days in the year than any other area on the continent."

However, the difficulties in meeting the needs of this great valley have been great. Its problems are not only unique but they are new, at least in this country. "In 1900 this great valley was an uninhabited solitude with scarce vegetation." It is now one of the leading agricultural counties of California. Two-fifths of the national supply of cantaloupes, at present, come from Imperial County. In 1920 the value of all farm property in Imperial County was $69,000,000 and the value of the crops, not including animals and animal products, was in 1919, $17,000,000, or about $6000 per farm.* It may be doubted whether any similar agricultural transformation has ever taken place.

In common parlance the valley has two types of soils, viz., "hard soil" and "soft soil." The station is located on hard soil. The most intensive crops, such as lettuce and cantaloupes are generally produced on soft soils. It therefore happens that the station is not in a position to study effectively some of the problems of most immediate interest to the valley.

Crops can be raised only by irrigation and, as the evaporation both because of high temperature and low humidity is rapid, the usual problems connected with rise in the water table have arisen. The valley slopes up from the north to the south. The cultivation of crops of intensive character, such as lettuce and cantaloupes, has gradually moved from the north to the south side of the valley. The problems connected with these phenomena are, as is well known, the most intricate and most difficult with which agricultural investigators have to deal.

The solution of the problems of this truly "imperial" valley would require the constant service of a staff of high technical training. Men of the necessary training and ability command such salaries elsewhere that if they have families they prefer not to bring them into this environment. A permanent staff of properly trained men can be maintained only with the greatest difficulty.

Control of Citrus Scale Insects by Parasites

There has existed for many years in connection with the Pest Control Division of the State Department of Agriculture, a laboratory for the study of parasites suitable for the eradication of scale insects

* For purposes of comparison it may be stated that the gross value of crops per farm in 1919 in the United States was $2300.

injurious to citrus fruits. In accordance with the recommendations of the Director of the State Department of Agriculture, the funds which normally would have come to the State Department for this purpose were by the last Legislature placed at the disposal of the College of Agriculture. The Legislature also passed a law enabling the Regents to employ and send abroad expert entomologists to collect and import "Parasitic and predaceous insects for use in the control of black scale, red scale, and other insect pests of horticultural and agricultural crops."

The insectary which has been used by the State Department for three years for this work, located at Whittier, Los Angeles County, is the property of the University of California. The work of receiving, breeding, and distributing parasites will be continued from that laboratory. The chief of the Division of Pest Control of the State Department of Agriculture, Harry S. Smith, has been appointed to the staff of the College as Associate Professor of Entomology and will be transferred from Sacramento to the Citrus Experiment Station at Riverside.

There are three steps in the problem of parasite control: (1) the discovery by explorers of parasitic insects in other countries having similar climatic conditions and host plants; (2) the careful study of such parasites to determine accurately their life history and habits, in order to make sure that beneficial parasites are introduced and not harmful parasites which may destroy the beneficial ones; and (3) the working out of practical methods of distributing suitable parasites thus discovered and studied. In this problem the "neck of the bottle" appears to be the discovery by explorers of suitable material and their transmission to the home laboratory. This has proved to be expensive, tedious, and uncertain work.

Agriculture in High Schools

By the passage of the Smith-Hughes Act (1917), rapid development has taken place in secondary instruction in agriculture. The Act provides that

> the controlling purpose of such education shall be to fit for useful employment; that such education shall be of less than college grade and shall be designed to meet the needs of persons over fourteen years of age who are preparing for a trade or industrial pursuit.

Speaking broadly, the Smith-Hughes Act seeks to do for secondary education what the Morrill Acts did for higher education. The College of Agriculture views with great pleasure the increased interest

thus created in agricultural instruction in the high schools. Such instruction is especially important for pupils who are not able to continue their training in the University. Both the requirements for entrance to the College of Agriculture and the curriculum in the College have been adjusted to meet the growing development in the high schools. Since the passage of the Smith-Hughes Act there has been much feeling of the way by the "trial and error method." Not only in California but throughout the United States, many readjustments have had to be made. On the whole progress has been satisfactory.

The relation of the College of Agriculture to this problem is largely unofficial and where official is through coöperation with the State Department of Education. The College of Agriculture is ambitious to develop its teacher training work to the highest degree of efficiency. It hopes to attract students to this work in order that it may supply the demand not only of this state but also of other western states for teachers of agriculture. Of the 361 high schools and junior colleges in California, 121 offered courses in agriculture during the year 1922–23, in 57 of which the instruction was conducted under the Smith-Hughes Act. The aggregate number of pupils enrolled is about 3000. There were 69 graduates of the College teaching agriculture in the California high schools during the present year. California has never been able to supply the demand for teachers of agriculture.

Junior College Work

Under the present organization of curricula within the College of Agriculture, a student who has finished two years of satisfactory work in some other college can secure the B.S. degree usually in three years. When the right subjects have been chosen in the beginning institution, it is sometimes accomplished in two and one-half years. Two years are not sufficient to give that degree of technical training which seems desirable in California where the agricultural industries have been brought to a high degree of specialization in subjects such as animal husbandry, dairying, agronomy, pomology, citriculture, and forestry. It is easily possible, however, for junior and other colleges which give suitable courses in mathematics and science to offer one year of work towards the bachelor's degree in the College of Agriculture.

Two years in a junior college and three years in the University would probably be desirable were it not for the fact that it lengthens the necessary period of instruction. From an economical point of

view it may well be questioned whether the industry of agriculture could stand five years of training for the majority of students. In the professions, such as medicine, law, and teaching, there is a legalized monopoly which does not obtain for those interested in agriculture and commerce. The effect of the longer training in law, medicine, and teaching not only results in securing adequately trained men, which is essential, but it also reduces the number entering these professions, thus protecting them from undue competition. It is the price we wisely pay to obtain a proficient personnel in these professions. In the nature of the case, no such protection is accorded to men trained in agriculture or commerce. I hope to see the day when five years of University training will be justified for students in agriculture. Those who engage in teaching and investigation should have training for at least five years. Junior college work in agriculture adequate to meet the present demands in this state is now provided by the University at Berkeley and Davis, and by the Chaffey Union High School at Ontario.

Requirements for Admission to College

Admission to any of the colleges of the University, including the College of Agriculture, is obtained by passing examinations or by the completion of a high school course approved by the State Board of Education and the recommendation of the principal of the high school from which the student graduates. The requirements of the State Board of Education are sufficiently elastic to enable the local boards to meet the various needs of the high school pupils.

There are two opposing views concerning the requirements for admission to the University. One is that only a few picked men and women of the highest scholarship and earnestness of purpose should be admitted to the university, and that all others should be denied a university education. The other view is that every person beyond high school age has an equal right to enter the university without regard to whether he or she can make profitable use of the facilities offered. According to this view, persons may fail in their studies and may never qualify for a degree, but as long as they desire to try to improve themselves they should not be denied the opportunity of remaining in the university. Both are extreme views. In education as in other affairs, one must be practical. The plan of admission now in vogue in the state is probably the best that has ever been devised. In the nature of the case no plan will work perfectly. There will always be some who are unworthy. My observations as student

teacher, and administrative officer, covering a period of forty-three years, convince me that not more than five per cent of the students fail to make worth-while if not completely satisfactory use of the opportunities offered, and not more than one per cent may be considered wholly unworthy of the efforts bestowed upon them. Many gibes and quirks are leveled at university students. Of course all young men and women are subject to the vicissitudes of their age, but no other group of young men and women are to be found anywhere with such high ideals and such earnestness of purpose as those who attend the university. If anyone doubts the contrast between the young men and women in the university compared with those outside of it of the same age, he has only to step into the poolrooms and other places of recreation where the latter congregate.

The Responsibility of the Secondary Schools

While precise data are not at hand, it has been estimated that as high as fifty per cent, in a number of instances, of the graduates of high school fail to receive the principal's recommendation and thus, except through examination, are barred from entering the university. It is obviously not desirable that a large body of prospective citizens should be left in a blind alley. Every young man and young woman should have an opportunity for study up to the age of majority. The only argument that can be made against such a programme is one of expense. However, it does not necessarily follow that the university curricula as now constituted provide the best training for all students. It may be that the hopeless attempt of some students to make use of university studies wastes the best years of their lives and prevents them from pursuing other studies or receiving other training for which they may be admirably constituted. This is, of course, not an argument against the continuance of education beyond the high school, but rather emphasizes the need of a greater variety of educational facilities.

There are two possible solutions, both of which are probably desirable. One is the offering by high schools of further preparation for entrance to college to those graduates of the high schools who have not been sufficiently proficient to warrant the principal's recommendation. The other solution would be to erect other institutions or additions to the facilities of existing institutions to meet the needs of such students. So far as relates to students in agriculture, the non-degree curriculum offered at the Branch of the College of Agriculture at Davis is an attempt to meet that situation as discussed in another paragraph.

The Commission on Agricultural Education in its conclusions recommends that

> the admission requirements of the College of Agriculture be maintained at the same level as those for the rest of the University, but that attention of the proper authorities be called to the excellent records of many non-recommended high school students enrolled in the University Farm and to the possibility of a more satisfactory standard for recommendation from the high school to the College of Agriculture.

The preparation of students for entrance to the University is the problem of the secondary schools. There appears to be no legal inhibition of offering a fifth year by the secondary schools to students who upon graduation fail to secure the principal's recommendation. The desirability of making such provision should be impressed upon the local boards of education.

State System of Education

Instruction in agriculture, whether in the university, junior colleges, high schools, or the grades, can be considered only as a part of the whole system of education. Indeed, research and instruction in agriculture, including the Agricultural Extension Service, is a part of a national system as discussed elsewhere under the paragraph on "Legal Requirements." One of the problems should there be created two colleges of agriculture in the state functioning separately, would be the disposition of funds from Federal appropriations. For example, the Smith Lever Act provides:

> That coöperative agricultural extension work shall consist of the giving of instruction and practical demonstrations in agriculture and home economics to persons not attending or resident in said colleges in the several communities, and imparting to such persons information on said subjects through field demonstrations, publications, and otherwise; and this work shall be carried on in such manner as may be mutually agreed upon by the Secretary of Agriculture and the State agricultural college or colleges receiving the benefits of this act.

If a college of agriculture were organized in southern California which functioned separately from the existing College, even though under the same Board of Regents, would it conduct investigations and would it have a separate Extension service? If a separate Extension service and a separate experiment station, would the facilities of the existing College of Agriculture be denied to that portion of the state?

These questions are not raised because of their immediate importance, but to point out that notwithstanding that the problem of a proper state system of education has been given much study both by official and unofficial committees and some constructive progress has been made, it appears that the citizens of this state have not yet crystallized their ideas and such programmes as exist are generally piecemeal enterprises. It was painfully evident in the hearings before the committee appointed by the Governor to consider a site for a school or college of agriculture in southern California that the relations of such a school or college to the general problem of agricultural investigation and teaching within the state was not well understood. It is equally evident that a suitable plan for the different activities of the University of California, the teachers colleges and junior colleges has not yet crystallized in the minds of the people.

The citizens of California, as in other things, desire the best there is in education. In many details the present facilities are unequaled. In the past, Californians have been willing to pay. There is every reason to believe that an increasing proportion of the state revenues will be applied to education. It is to be hoped that some man or some group of men will arise who will be able to lead in organizing a comprehensive system of education suited to the various needs of this complex commonwealth. Research and education in agriculture must not be organized apart.

Qualifications of Personnel

In an institution like the College of Agriculture in which the aim is to aid a great industry and enrich the lives of those engaged in it, there are two aspects in the development of a personnel. On the one hand there is the problem of obtaining persons with well disciplined minds, but over and above this is the problem of keeping the minds of these persons growing. President Wheeler's dictum that "no one will have anything to do with anything that is not growing" applies to persons as well as to things. Studious habits are of prime importance. Men of brilliant promise sometimes fail to grow after their permanency in an institution is assured. Having found a haven of refuge, they sometimes develop traits heretofore little anticipated.

On the other hand, there may be danger from too intensive study. A too long period devoted to study in some special field of knowledge sometimes unfits or disinclines persons to make the necessary application of their knowledge to the problems of agriculture. The mind

retires into an enclosure which reduces its effectiveness. One of the greatest difficulties surrounding the conduct of public affairs is the disposition of groups of people to build barriers which exclude the knowledge and the contact necessary to the wisest conduct of their responsibilities. Such persons are apt to see their problems only through a crack.

There is, therefore, not only the economic problem connected with the length of curricula, but there is a pedagogic problem as well. For example, it may well be doubted whether, in the main, seven years of continuous university study is advisable for men who are to become members of the staff of a college of agriculture. A more ideal arrangement consists in four or five years of study followed by two or three years of employment in investigation or teaching. Subsequent additional graduate study in those fields which experience has shown to be the person's greatest need or interest may then be highly advisable, if not essential.

During the past decade the policy of the College of Agriculture in calling persons to its membership has been to ask three questions:

1. Does he know a subject?
2. Is he a sound investigator or an inspiring teacher or both?
3. Does he get along well with people?

These policies have resulted in securing in the main an able and enthusiastic group of men and women devoted to the aims and principles of the College of Agriculture. There is reason to believe that the staff has a greater percentage of efficiency than that of large business enterprises in general. That it could be more efficient goes without saying. Probably, however, no similar group brought together to solve the problems of the farmer has maintained a more correct attitude or accomplished more useful results. It has been an inspiration to be associated with them for more than a decade. It is an opportunity for which I am profoundly grateful.

Very respectfully submitted,

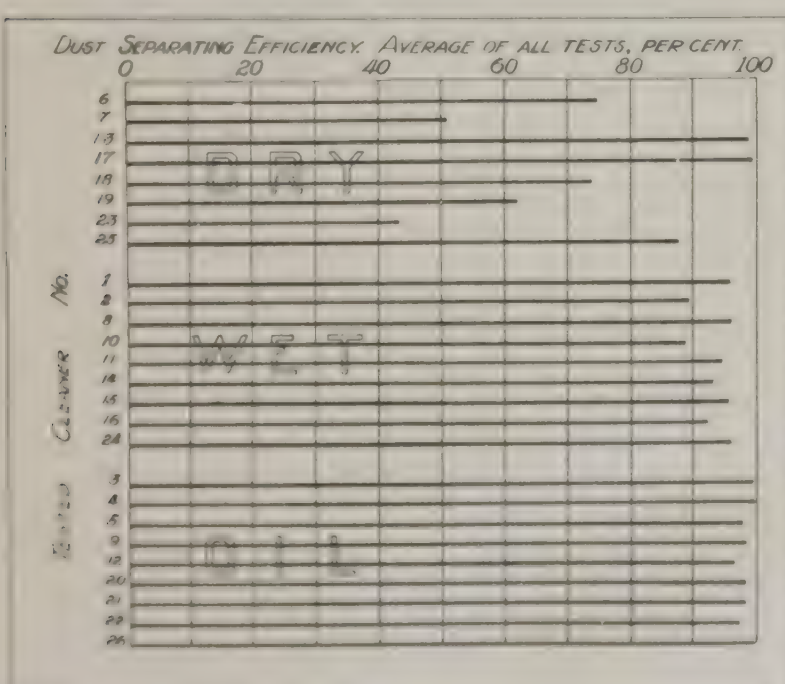
THOMAS F. HUNT.

ACHIEVEMENTS OF THE DIVISIONS OF THE COLLEGE AND STATION FOR THE YEAR ENDING JUNE 30, 1923

This section of the report includes summaries of the activities of the various divisions. The paragraphs were prepared by the members of the staff and supplement the information given in previous annual reports. In most cases the results described were achieved under Experiment Station projects.

AGRICULTURAL ENGINEERING

Test of Air Cleaners for Tractor Engines.—Efficiency, vacuum, and power tests have been completed on twenty six air cleaners. This work was accomplished by the use of apparatus largely designed and built by A. H. Hoffman and B. D. Moses. A reprint of a complete report of this work, including full description of the apparatus and results obtained, may be secured upon request from the Agricultural Engineering Division, University Farm, Davis. A condensed report has been submitted for publication as Bulletin 362 of the Agricultural Experiment Station. It is entitled "Dust and the Tractor Engine" and is designed especially for the tractor user. In addition to the results of the tests, it contains material on how to get best results from air cleaners.



Efficiency % Average all tests	Service run	Low water	No. tested cleaner
74.7	67.4		6
51.0	50.3		7
98.7	97.8		13
99.4	99.5		17
73.3	72.5		18
62.2	58.8		19
42.7	37.6		23
88.5	87.4		25
96.0	96.1	95.2	1
89.3	85.8	83.6	2
96.5	97.3	95.0	8
88.9	89.8	86.6	10
94.6	94.4	[illegible]	11
93.1	92.6	[illegible]	14
95.7	95.8	Constant level	15
92.4	94.0	85.9	16
95.9	95.2	Not run	24
99.5	99.9		3
99.8	99.9		4
97.8	98.0		5
98.5	99.5		9
96.6	96.9	Oil 94.7	12
98.4	98.2		20
98.8	98.6		21
97.4	97.1		22
99.5	99.6		26

Fig. 15.—Results of the test of air cleaners for tractor engines. Note that the oil type is uniformly most efficient, the water type next, while the dry type varies 42.7 per cent to 99.4 per cent efficient, according to the principle involved.

Schweizer Electrical and Italian Methods of Green Forage Preservation.—In continuance of the coöperative work reported last year* by A. H. Hoffman and the late Dr. F. W. Woll of the Animal Husbandry Division, retrial was made of the electrical method of green forage preservation, using different forage materials.

For this year's tests the silo jars, 30 inches in diameter, were increased to a height of 48 inches. Jars 1 and 2 were filled with 623¾ pounds of corn and 703¼ pounds of honey sorghum, respectively, and treated by the electrical method in the same manner as previously reported, except that the jars were surrounded with a covering of straw to reduce heat loss and hence to reduce the cost of electric energy. Jar 1 required 8.58 kw.-hr. to bring the temperature of the contents

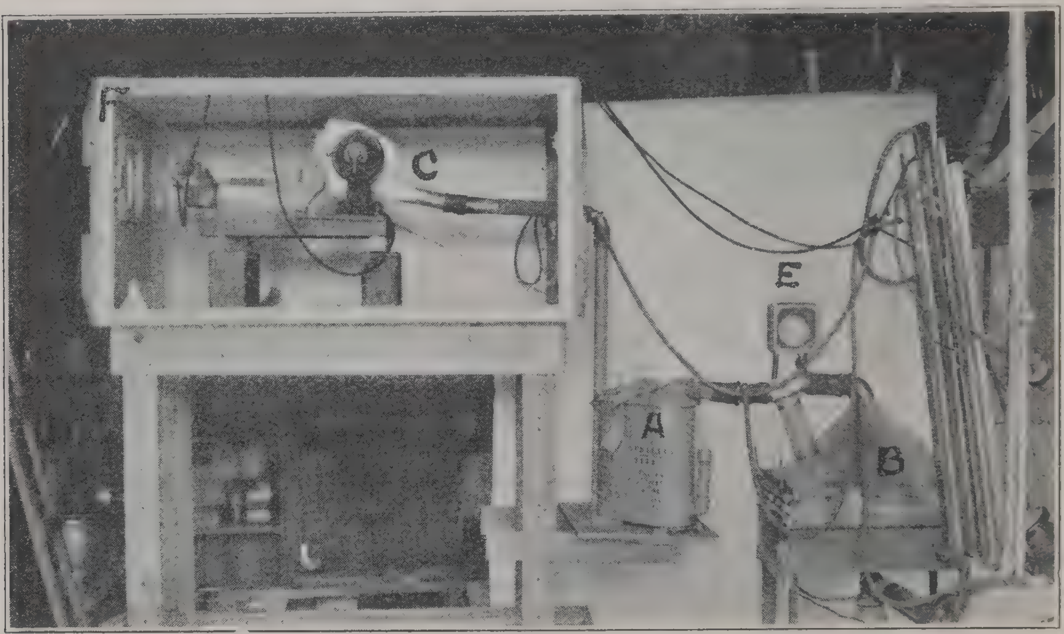


Fig. 16.—A typical set-up for an efficiency test of a water-type air cleaner. A, the air cleaner under test; B, the "absolute cleaner"; C, the dust feeding device; E, hygrometer; F, cage to insure clean air coming to dust feeding device. (Side of cage removed for photograph.)

to the required 122° F., and Jar 2, 11.38 kw.-hr. (i.e., 27.5 and 32.4 kw.-hr. to the ton, respectively). The difference was due mainly to the fact that Jar 2 had a handicap of 16° F. lower starting temperature, since the honey sorghum was cut early in the morning and the corn near noon. The first cost of the necessary electrical equipment, together with the recurring expense for electric energy, makes this method of doubtful economic value. Data on palatability and observations on the Italian method of green forage preservation are reported by the Animal Husbandry Division, p. 89.

Measurement of Soil Pulverization.—In tests on plows considerable apparent difference in the pulverization effected at different speeds has been noticed. In the endeavor to find out whether the increased pulverization would pay for the increased draft at higher speed, much time and effort has been put forth by A. H. Hoffman to find some means of measuring soil pulverization. Inquiries at all the United States' Agricultural Experiment Stations revealed

* Report of the College of Agriculture and Agricultural Experiment Station, University of California, 1291–22, p. 59.

that no work of this nature had been done. All methods suggested were considered and if deemed promising, were tried out. After these preliminary trials, two methods were adopted. The first determines the percentage of soil caught on each of a set of seven screens placed one above another. The screens are of wire, square mesh, 8-inch, 4-inch, 2-inch, 1-inch, $\frac{1}{2}$-inch, and $\frac{1}{4}$ inch, with solid bottom pan. The samples weigh from 50 to 60 pounds each, and are taken in such a way as to be representative of the whole depth of furrow slice. Results obtained check very closely in the same soil, and different soils show markedly different pulverizations, as shown in figure 17. No means has yet been found for representing by a single number the results obtained by screening a sample. The screen method was first devised and used by the Agricultural Engineering Division in the late summer of 1919.

The second method measures the density of the soil before and after tilling. The ratio of density before to density after tilling, may be called the pulverization. Careful preparation is being made to carry this work to definite results.

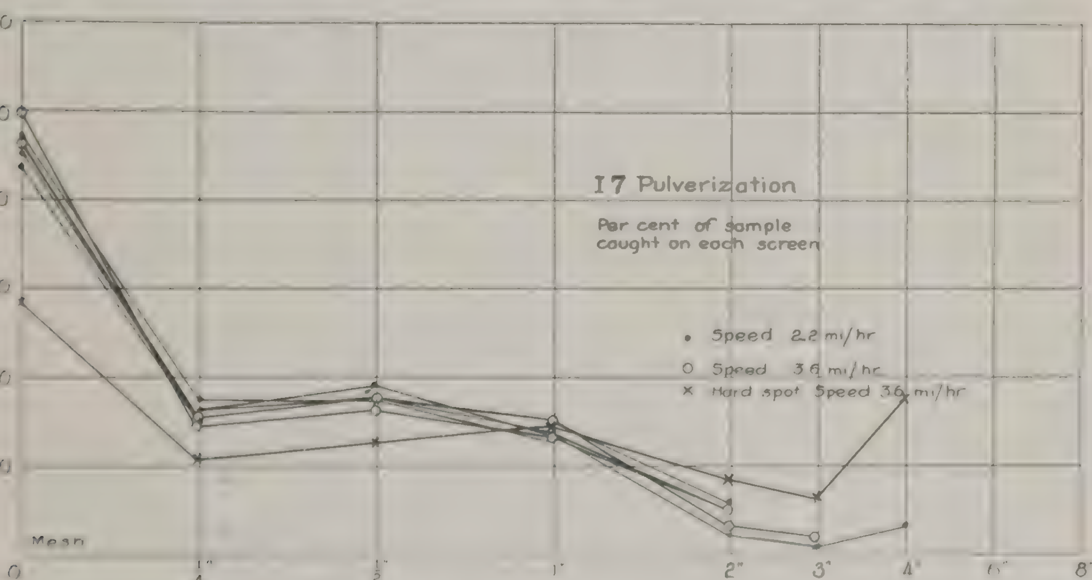


Fig. 17.—Measurement of soil pulverization produced by plowing at various speeds.

Improved Type of Orchard Brush Burner.—An investigation was made by W. L. Zink of orchard brush burner requirements under various orchard conditions. The study included effect on trees, draft regulation, power required for pulling, durability, cost, and ease of construction. The burner designed consists of a sheet iron fire pan of the suspension type, carried on a braced angle iron frame and transported on skids. The burner is 8 feet long and 5 feet wide, and at the highest point is $2\frac{1}{2}$ feet above the ground. It is built of $2\frac{1}{2}$ in. by $2\frac{1}{2}$ in. by $\frac{1}{4}$ in. angle iron, with $\frac{1}{2}$ in. tie rods, $\frac{3}{8}$ in. by $1\frac{1}{2}$ in. braces, and 16 gauge sheet iron fire pan. Draft openings consist of narrow slits $1\frac{1}{2}$ in. by 10 in. long arranged in rows along each side of the pan. Ashes drop through seven $\frac{3}{4}$ in. by 10 in. slits in the bottom of the pan. The burner weighs 300 pounds and the material in the burner, if purchased new, costs approximately $18. Oftentimes an old tank may be used for the fire pan. The remaining material will cost about $12. The burner is easily pulled by two horses or mules, the pull averaging 250 pounds on soft ground.

Effect of Carburetor Adjustment on Fuel Consumption.—An experiment by L. J. Fletcher indicates that in the fuel consumption of an internal combustion engine there is a possible increase of nearly 100 per cent between a lean and rich fuel-air mixture ratio.

A 12-20 tractor, provided with a constant load, was used to obtain the following results:

Test No.	Carburetor needle valve Opening	Fuel Used	
		the hour	Gallons to the acre (20 ft. smoothing harrow)
1	174°	.91	.19
2	240°	1.23	.23
3	300°	1.50	.30
4	330°	1.73	.38

In test No. 1 the mixture was made as lean as was possible without causing heating of the engine, backfiring, or appreciable loss of power. In test No. 4 the mixture, while very rich, was not so rich that black smoke appeared in the exhaust gas or that it caused the engine to "gallop" or lose power.

These results indicate the importance of proper carburetor adjustment and the impossibility of readily detecting rich mixtures by engine performance.

Rod Row Thresher.—An improved type of rod row thresher has been designed and built by A. H. Hoffman, assisted by W. L. Zink and J. S. Winters. Its main features are thorough threshing; removal of straw and chaff; simplicity; self-cleaning between bundles without stopping of machine (hence no mixing of seed); reduction to a minimum of the loss of seed; and adjustability of concaves and of speed. It removes the culms from barley but does not crack dry wheat. An electric motor or gas engine drive may be used. Blueprints Nos. B–12–3 are available.

Mechanical details: The cylinder is a closed gray iron casting, 10¾ in. in diameter by 8 in. in length; the concave is a two-piece gray iron casting placed overhead, ¾ in. thick by 8 in. long by 160 degrees; the teeth are forged from ⅜ in. round mild steel, ends case-hardened, effective length 1¾ in. and are arranged 48 in six rows on the cylinder and 27 in three rows on the concave; the throat is 5 in. high by 8 in. wide; the fan is cap-screwed to the cylinder end, is 15⅝ in. in diameter by 3¾ in. in width and has six blades.

Breaking Tests of Engine Type Cutaway Disk Harrow Blades.—Experiments reported in 1921–22 showed that ordinary cutaway blades break much more readily than full blades. Eight blades of extra thickness were put in the compression test. The test loads borne show these amply strong to withstand all ordinary side stresses encountered in use.

Three-Horse Hitch for Wagon.—R. R. Thomson designed an attachment for an ordinary three-horse plow hitch so that three horses may be used on an ordinary wagon without moving the tongue or making additional holes. This arrangement practically eliminates side draft effects by means of a short spacer and a chain which connects the hitch to the rear axle of the wagon. The attachment is quickly made and the materials used in it are on practically all farms. A plan, number A–13–1, describing this hitch is available.

Fig. 18.—A view of the orchard brush burner designed and built by W. L. Zink. It is 8 feet long, 5 feet wide, and 2½ feet high. The material in it costs approximately $28. It is easily pulled by two horses and is low enough that no damage is done to the trees. The brush is easily loaded.

Fig. 19.—A detailed view of the orchard brush burner. The fire pan is of [illegible] gauge sheet iron. The frame is built mainly from 2½ in. by 2½ in. by ¼ in angle iron.

Fruit Packing House.—This building, designed by H. L. Belton and J. D. Long, in coöperation with W. P. Duruz of the Pomology Division, is a 30 ft. by 52 ft. house with sawtooth roof and latticed ends, providing, with the windows and large receiving doors in the side walls, a maximum of light and ventilation.

A special truss of simple construction and of easily procured material is designed to carry the roof load on the side walls, leaving the floor space clear of posts or other obstructions. Ample room is provided for four 15-foot packing tables, an inspection table, a nailing press, and an office.

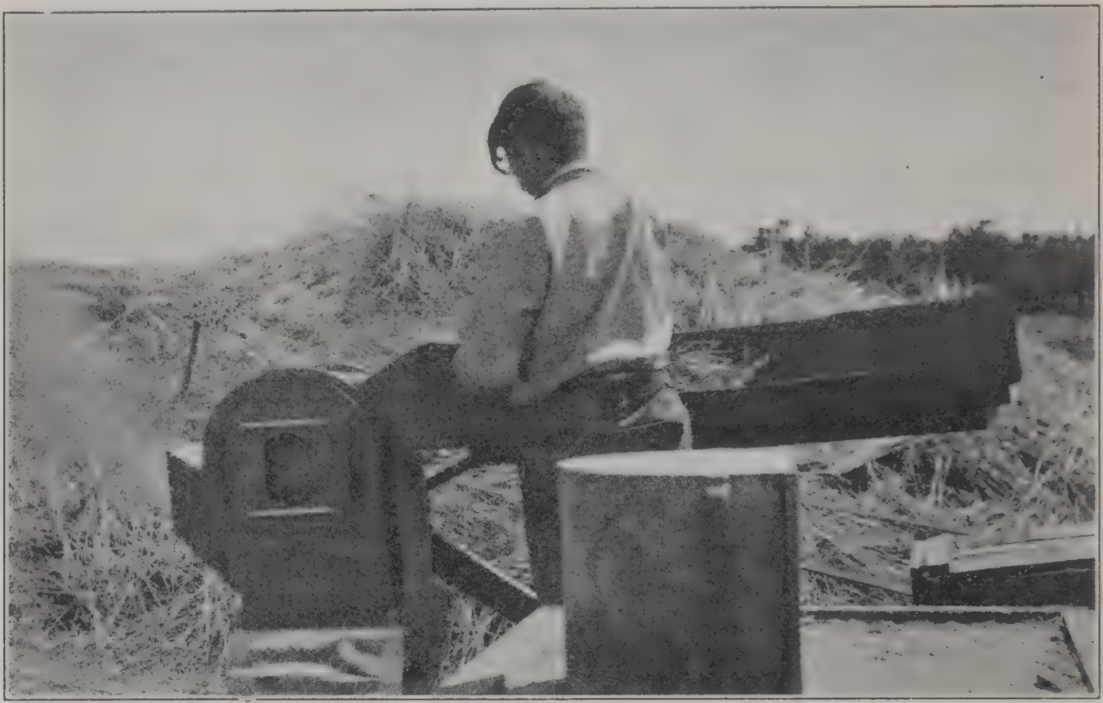


Fig. 20.—Miniature thresher and separator designed primarily for rod-row harvests of small grain, but usuable for threshing various seeds. Its best features are extreme simplicity of construction, automatic cleaning out between bundles, avoidance of loss of seed, and adjustability. Its weight is about 200 pounds.

A covered loading platform in front and a covered drive in the rear protect the latticed ends of the house from storms. Receiving doors are placed at both sides and at the rear end of the house, and the floor plan arrangement is such that the fruit may be handled in one continuous stream from the rear to the front of the house without confusion or retracing the path of movement. The file number of the plan of this building is B–10–4. The estimated cost is about $1800.

Fruit Cutting Table.—Plan B–43–1, designed by H. L. Belton in coöperation with W. P. Duruz of the Pomology Division, is of an 8-foot cutting table for four workers. An 8-foot fruit packing table was also designed and is described in Plan B–45–1.

Milk Houses for the Dairy Farm.—H. L. Belton and J. D. Long, working in coöperation with the Dairy Industry Division, the State Department of Agriculture, and various City Boards of Health, and after numerous conferences with Dr. C. L. Roadhouse, Dr. J. J. Frey, and certain of the state dairy inspectors,

designed four milk houses varying in size from 6 ft. by 6 ft. to 20 ft. by 32 ft. Of these but one size, the 6 ft. by 16 ft., has as yet been made available for blue print distribution; the others, being of a size less in demand, are to be included in a circular on this subject.

The 6 ft. by 16 ft. house plan now available may, with few changes, be adapted for either cream or market milk production for a herd of from ten to thirty cows. It consists of a 6 ft. by 10 ft. milk room with a concrete cooling vat of two 10-gallon can capacity and sufficient space for a tubular cooler or separator, table and can drying rack, and a 6 ft. by 6 ft. open front wash room to contain the wash sinks and the sterilizer. The open front of the wash room may be screened, if desired. The plan shows a concrete foundation, floor, and side wall fifteen inches above the floor, frame walls using T. & G. flooring placed vertically on the outside, and for the milk room a recommended inside ceiling of T. & G. flooring or hard cement plaster, and a shed roof covered with prepared paper roofing. The estimated cost of the house, both labor and materials being included, is $125. The file number of this plan is B-3-4.

Dairy Cattle Breeding Rack.—A substantial, easily constructed stanchion rack adjustable for various sized cows was designed by H. L. Belton and J. D. Long. The plan, B-6-2, also shows a possible arrangement of breeding rack and bull pen to eliminate handling the bull.

California Shed Roof Type Poultry Laying House.—After an investigation of poultry houses in five of the leading poultry producing sections of the state, H. L. Belton, coöperating with J. E. Dougherty of the Poultry Husbandry Division, designed a new type of laying house.

A unit 18 feet wide and 20 feet long is so designed that a litter carrier may be installed and droppings removed directly from the boards to the carrier. There are five rows of roosts, and special provision is made to prevent drafts from striking the birds when on the roosts. A concrete floor and foundation are used, together with side walls of T. & G. flooring applied vertically, a muslin curtain front, and a three ply prepared paper roof. The house is 9 feet high in the front and 5 feet 6 inches high in the rear. Over 3860 running feet of this type of house have been built since the investigation. The average cost is about $1.50 a bird, allowing $2\frac{1}{2}$ square feet for each bird. A 100 foot house, accommodating 800 birds, costs approximately $1200. Plan B-53-7, describing this house, is now available.

Farm Structure Plans.—Plans of farm structures designed by the staff members of the College of Agriculture may be borrowed free of charge from the Agricultural Extension Division, University of California, Berkeley.

Following is a list of available plans revised to May 1, 1923:

B-1-2	Beef Barn for Feeding Hay.
B-3-4	6'x16' Milk House.
B-6-2	Dairy Cattle Breeding Rack
B-7-2	Concrete Manure Box.
B-10-4	Fruit Packing House.
A-13-1	Three-Horse Hitch.
C-15-1	Movable Hog House.
B-18-1	Portable Sheep Manger.
B-19-2	Self Feeder for Swine (Style 2).

C–22–1	Community Hog House (Iowa Type).
C–23–2	Small General Purpose Barn.
C–28–4	Standard California Type Dairy Barn.
C–29–1	Hay Storage Barn.
C–30–1	Detail Showing Construction Bent Rafter Dairy Barn.
C–33–2	Farm Implement Shed.
C–35–2	Monolithic Concrete Silo.
B–37–1	Modified Feed Rack for Sheep.
B–38–2	Hay Rack for Cattle.
B–39–1	Feed Rack for Sheep No. 2.
A–40–1	Lambing Hurdle.
A–41–1	Diagram Sheep Dipping Vat.
A–42–2	Bunk House, Sketches.
B–43–1	Fruit Cutting Table.
B–44–2	Ford Power Attachment.
B–45–1	Fruit Packing Table.
B–46–1	Lock for Barns and Box Stalls.
B–47–2	Hoof Trimming Crate for Swine.
C–48–2	Work Stock Barn for 16 Head.
C–49–2	Work Stock Barn, 1-story type.
C–50–4	Standard Milking Barn for 120 Cows.
B–51–6	16′ x 20′ Poultry House, Shed Roof Type.
B–52–6	16′ x 20′ Shed Roof Poultry House, All Curtain Front.
B–53–6	16′ x 20′ Shed Roof Poultry House, Designed for Litter Carrier.
B–54–5	Small Milking Barn for 10 Cows.
B–55–4	16′ x 30′ Brooder House.
B–56–1	Portable Fence Panel for Hog or Sheep.
B–57–4	5′ x 6′ Knock-Down Poultry House.
B–59–2	Dipping Vat for Hogs and Sheep.
C–60–1	Parting Chute for Cattle (After T. S. Glide).
B–62–1	Parting Chute for Sheep.
B–63–2	Continuous Lambing Jails, Sheltered with Panel Roof.
B–64–4	8′ x 8′ Knock-Down Poultry House.
B–65–1	Shed Roof Brooder House.
C–72–2	Four-Room Bunk House No. 1.
B–77–1	Stockyard gate with latch that can be operated from horse-back.
B–78–1	Breeding Stall for Dairy Cattle.
C–79–1.	Seed House for Grain Sorghums.
C–81–1	Breeding Rack for Swine.
C–82–1	Frame Water Tower for 5000-Gallon Tank.
B–84–1	Shipping Crate for Swine.
B–87–1	Bean Cutter—Sled Type.
B–88–1	Silage Bunk or Manger for Beef Stock.
B–89–1	Device for Placing and Removing Wagon Racks.
B–93–1	Corn Cutter—Sled Type.
B–94–1	Concrete Vat for Cooling Milk.
B–98–1	Alfalfa Feeder for Swine.
B–100–2	Rabbit Hutch—A.
B–101–1	Knock-Down Outdoor Rabbit Run.

AGRONOMY

Comparative Grain and Stover Yields for Dwarf Milo and White Yolo.—In trials at Davis G. W. Hendry found White Yolo to yield more grain and less stover than Dwarf Milo when grown without irrigation. The average yields were as follows: Dwarf Milo, 3155 pounds of grain, and 5.57 tons of air dry stover to the acre; White Yolo, 3447 pounds of grain and 4.53 tons of air dry stover to the acre.

An average Milo plant consisted of 23.2 per cent grain and 76.8 per cent stover by weight, and an average Yolo plant 26.7 per cent grain and 73.3 per cent stover. Dwarf Milo heads consisted of 79.9 per cent grain by weight, and White Yolo heads 82.19 per cent grain by weight.

Comparative Soil Moisture Draft of Dwarf Milo and White Yolo.—An examination of the soil to a depth of four feet following harvest, revealed a higher residual moisture content upon plots which had produced White Yolo than upon those which had produced Dwarf Milo. G. W. Hendry and J. P. Conrad report that for Yolo the moisture content was 0.5 per cent higher for the first foot, 1.1 per cent for the second foot, 1.4 per cent for the third foot, and 1.3 per cent for the fourth foot. An adjoining summer-fallowed plot was found to have a higher moisture content than the White Yolo plot, distributed as follows: 3.8 per cent higher for the first foot, 6.5 for the second, 7.0 for the third and 7.1 for the fourth foot. Studies are now in progress to determine the effects of such varying moisture residues upon the yield of succeeding small grain crops. This bears particularly upon the choice of fallow crops for dry land rotations. Several leguminous crops in cultivated rows, including cowpeas and alfalfa are also being tested in this connection.

Height Variability in Yolo and Milo.—J. W. Gilmore measured the height of 1947 Dwarf Milo plants and an equal number of White Yolo plants to obtain an index to height variability. The total height range of unirrigated White Yolo was found to be 23 inches and of Dwarf Milo 54 inches. The percentage of heads standing between 40 and 50 inches above ground was found to be 90.3 for Yolo and 70.5 for Milo.

Selective Improvement of Yolo.—Continuing the work of selective improvement,* 20 individual outstanding plants of White Yolo and 13 of Brown Yolo were selected in 1921 by G. W. Hendry and sown in 1922 in "head to plot" plantings. These plants were chosen for productiveness, earliness, dwarfness, and single stalk habit, and their progeny have exhibited marked variability in these characteristics. A number of them have been planted in a systematic, replicated, variety trial nursery in 1923 with checks. Several hybrids have also been made in an attempt to combine the desirable characteristics of Dwarf Spur Feterita, Double Dwarf Milo, and White Yolo.

Mechanical Heading Devices for Grain Sorghums.—Further tests† of grain sorghum heading machinery were made in 1922 by G. W. Hendry. Of the six machines used, three were the "one row" wagon bed type, one a binder, one

* Report of the College of Agriculture and Agricultural Experiment Station, University of California, 1920–21, p. 33.

† *Ibid.* 1921-22, p. 49.

a push header, and one a harvester thresher. One of the row headers had been improved since the 1921 tests and operated more efficiently. Another of the ''one-row'' headers was new in principle; it was constructed like a stripper and designed to head irregular and tall growing varieties. The grain binder was effective in binding light crops of Yolo and Milo, but was too light in construction for heavier crops or for prolonged service. The bound bundles were threshed like small grains. The push header, designed for heading small grains, proved equally efficient in heading White Yolo. It is suitable for heading large acreages, which are too immature to cut with the harvester-thresher, but is unsuited to tall irregular growing varieties. Harvester threshers have never proved satisfactory for harvesting grain sorghums for two reasons: first, the crops have been too irregular and bulky in habit of growth, and secondly, they have not ripened uniformly or completely enough to be threshed directly from the stalk into the sack without heating. The harvester-thresher tested this season was found efficient in heading without waste, and in separating the grain completely from the head when equipped with the barley screens. Grain from completely ripened plants, grown on the lighter soil areas, went into the sacks very dry and remained sweet and cool when placed in piles in the warehouse, but most of the field contained enough green heads to cause heating in the sack, thus making it necessary to spread the grain on canvas in the sun. But even then the total harvesting cost was probably not greater than by methods including heading, curing of heads, and threshing as separate operations. Grain which heated gave one day after cutting a temperature of about three degrees above ''room'' with a gradual rise for four to six days, when blackening, moulding, and complete loss occurred. When room temperature was 68°, these sacks, one day after threshing, showed 71°. Other drier sacks showed rises of three degrees two to four days after threshing, and then gradual return to normal without deterioration. The combined harvester method is not suited to crops containing green heads or to heavy crops of Milo or Dura, which are irregular, but may be employed economically upon completely matured White Yolo or following killing frosts, which result in a drying of the heads. Upon moist soils or following early fall rains, any variety is apt to remain green too long to admit use of the combined method.

Tobacco for Nicotine Extraction.—NICOTIANA RUSTICA No. 34752 yielded from 800 to 976 pounds of stems and leaves to the acre, or from 216 to 263 pounds of dry leaves to the acre. The leaves contained 8 per cent nicotine and the stems 1.5 per cent. G. W. Hendry reports that the average yield of nicotine to the acre at Davis was 19 pounds. It is expected that variations in cultural practice may materially increase this average.

Variety Trials with Wheat.—J. W. Gilmore, V. H. Florell, and G. W. Hendry report that 20 superior varieties of wheat were grown in $\frac{1}{50}$-acre plots replicated five times. All of these yielded above 40 bushels to the acre. The best variety in respect to yield was Onas, producing 81.9 bushels to the acre.

Following are the varieties grown and the average yield of each: Onas, 81.9 bushels; Little Club, 78.2 bushels; Oudebaard, 71.5 bushels; ''Defiance'' (Red Kernel), 70.9 bushels; Early Baart, 70.6 bushels; White Australian, 68.1* bushels; White Federation, 67.4* bushels; Pacific Bluestem, 67.0* bushels; Boadicea, 66.9 bushels; Federation, 66.5* bushels; Sonora, 65.8* bushels; Canberra, 64.4* bushels; Bunyip, 62.8* bushels; Marquis, 62.1 bushels; Hard Federa-

tion, 61.4* bushels; Early Defiance, 66.7 bushels; Kaarkof, 59.2 bushels; Quality, 58 bushels; Sunset, 52.9 bushels; Bobs, 40.1† bushels.

Milling and Baking Tests with Wheat.—J. W. Gilmore, V. H. Florell, and G. W. Hendry report that the varieties of wheat grown in plots were milled and baked in the experimental mill of the Bureau of Agricultural Economics of the U. S. Department of Agriculture at Washington, D. C. Onas, Marquis, and Bobs showed the highest loaf volume, and Sunset, Quality, and Bobs the highest crude protein content. Bobs, Quality, Kaarkof, and Marquis produced the highest flour yields. All varieties were of comparatively good quality except Sonora, which had a low color score on account of smut.

Fig. 21.—Varieties of cereals at the Branch of the College of Agriculture, Davis. Numerous plantings of cereals are made at Davis and other stations in order to determine disease resistance, effects of seed treatment by various methods, and behavior under different culture methods.

Australian Wheat Varieties.—J. W. Gilmore, V. H. Florell, and G. W. Hendry report that in the Australian wheat nursery were grown nineteen of the best varieties, including Hard Federation and White Federation, formerly grown in the nursery at Chico. Of these nineteen, Federation C. I. No. 4734, was the leading variety. Twenty selections of White Australian were each grown in triplicate threes. The best of these was 40 W.

The Improvement of Wheat Through Hybridization.—J. W. Gilmore, V. H. Florell, and G. W. Hendry report that a very successful wheat hybrid nursery was grown this season consisting of F_1, F_2, F_3, and F_4 material. One hundred and five apparently pure lines were harvested from the F_4 material composed of three crosses designed to improve California wheats. Seven wheat crosses and four wheat rye crosses were made in 1922. In the former 720 florets were

* About 5 per cent loss due to shattered grain falling under feeder canvas in threshing.

† Average of two plots. Low yield resulting from poor drainage caused by "dead furrow."

pollinated, from which 389 kernels were harvested, or 54.0 per cent of apparently successful crosses. In the wheat-rye crosses 432 florets were pollinated and 160 kernels apparently crossed harvested, or 37.0 per cent. In the rye-wheat crosses 432 florets were pollinated and 60 kernels apparently crossed harvested, or 13.9 per cent.

The Classification of Wheat Varieties.—J. W. Gilmore, V. H. Florell, and G. W. Hendry report that the wheat classification nursery contained 230 rows with 166 additional rows in the identification and foreign wheat nursery. The entire group was sown in single 16-foot rows with the object of getting comparative yields in the classification nursery. Yield data were secured but they indicate comparative behavior in a very general way only, as three different sets of head samples were first collected from each row.

Fig. 22.—Nursery rows of cereals at the Branch of the College, Davis. In order to secure desirable qualities in wheat, oats and barley many hybrids are produced and given their first trial in nursery rows.

Variety Trials with Barley in Plots.—J. W. Gilmore, V. H. Florell, and G. W. Hendry report that the varietal experiment with barley in plots contained 12 varieties which were sown in 1/50 acre plots replicated 5 times. Trebi, Arequipa, and Club Mariout, respectively, were the highest yielding varieties.

Variety Trials with Barley in Rows.—J. W. Gilmore, V. H. Florell and G. W. Hendry report that comparative experiments with barley in the nursery were sown in 20 foot rows, replicated 9 times (in replicate three's). Thirty-two varieties and selections were contained in the varietal experiment. California Mariout selection, Calif. No. 2296, was the highest yielding variety with 1119 grams to the row or at the rate of 111.9 bushels to the acre. Peru, C. I. No. 707, ranked second, and Trebi third. Forty-three of the best selections, from the large number of selections from commercial fields of Coast barley grown at

Chico since 1918, were contained in the Coast Selection nursery. 190 B, the highest yielding selection, produced an average of 986 grams to the row or at the rate of 98.6 bushels to the acre. The barley classification and identification nursery contained over 1200 five-foot rows.

Miscellaneous Wheat Varieties in Nursery Plantings.—J. W. Gilmore, V. H. Florell, and G. W. Hendry grew 49 varieties of wheat with checks in 16-foot rows, replicated nine times. The three highest yielding varieties of this series were as follows: Federation, 84.4 bushels to the acre; Pileraw, 84 bushels; and Dicklow, 80.5 bushels. The significant point in these trials is the fact that wheats vary widely in yield under similar conditions of culture. One of the outstanding problems in the improvement of our varieties is the selection of those wheats which are consistently high in yield and excellent in milling quality.

Barley Classification.—The barley classification and identification nursery contained over 1200 rows. This nursery was studied and harvested by M. N. Pope, Agronomist in Barley Investigations, Washington, D. C.

Variety Trials with Oats.—J. W. Gilmore, V. H. Florell, and G. W. Hendry report that three varieties of oats were grown in 1/50 acre plots. Guysa, Calif. No. 1013, the highest yielding variety, produced at a rate of 113.1 bushels to the acre.

Seed Distribution and Farmers' Demonstrations with Cereals.—Through the distribution of pedigreed seed and the systematic establishment of variety demonstrations throughout the state by County Farm Advisors, much useful knowledge of variety adaptation has been assembled, and special varieties adapted to special conditions are being generally adopted. During the year G. W. Hendry established demonstrations as follows: Hard Federation wheat, 34; White Federation wheat, 26; Bunyip wheat, 12; Defiance wheat, 18; miscellaneous wheats, 10; Mariout barley, 99; Tennessee Winter barley, 25; Four Thousand barley, 20; Peacock barley, 2; Burt oats, 16; Harding grass, 23; Robust beans, 8; White Yolo, 236; and University Farm Dwarf Milo, 53.

White Yolo.—Of the 65 farmers who reported comparative yields for grain sorghums, 25 expressed a preference for White Yolo, 14 for Dwarf Milo, 3 for Egyptian corn, and 23 withheld judgment. The average yield in sacks* to the acre were White Yolo 16, and Dwarf Milo 19. Milo yielded highest on moist soils and under irrigation. Yolo yielded highest on upland soils without irrigation.

Mariout Barley.—Mariout barley again demonstrated its superiority over Coast barley, by averaging 19.5 sacks to the acre in 99 demonstrations, against an average of 17.7 sacks to the acre of the Common (Coast) variety. Mariout barley is now well established in the San Joaquin Valley, in the upper Salinas Valley, and in the southern Sacramento Valley.

Tennessee Winter Barley.—Tennessee Winter barley has gained a wide distribution in the northern Sacramento Valley and in the cooler coast and mountain districts of northern California and in these regions on heavy soils, it has been the most productive variety in the demonstrations. Through the work of County Farm Advisor Russell T. Robinson, it has been planted on practically every grain ranch in the Livermore Valley in 1923, and is rapidly replacing other varieties in Mendocino County as a result of demonstrations by County Farm Advisor C. S. Myszka.

* A sack weighs approximately 135 pounds.

Four Thousand Barley.—Four Thousand barley is being substituted for Coast barley sporadically in many parts of California and by virtue of its greater productivity, is becoming popular under average conditions, which do not require the drought resistance of Mariout or the moisture resistance of Tennessee Winter barley.

Burt Oats.—Burt oats has exceeded common Red oats in yield in the majority of the demonstrations in which these two varieties have been tested comparatively, and it promises to become an element in the agriculture of the state, particularly in the interior regions.

The Federation Wheats have not created a favorable impression in the majority of the comparative demonstrations. Upon dry upland soils they have been at their best, but in more favorable situations and on moist soils they have been at a decided disadvantage with such later maturing varieties as Club, Pacific Bluestem, and Defiance.

Club (Oregon) Mariout Barley continues to gain in public estimation in the northern Sacramento Valley, and because of its bright color, thin hull, and plump kernel is in great demand for export shipment. It does not possess the earliness or drought resistance of California Mariout and is adapted to fall planting in the northern districts of the state.

Bunyip Wheat has been favorably reported upon by all growers and has become a prominent variety in most of the wheat districts of the state. It possesses earliness, abundant yield, quality, and stiffness of straw, and is encroaching upon territory formerly devoted to the production of other varieties.

Onas Wheat (C. I. No. 6221) is a promising new variety to be distributed for the first time in the fall of 1923. In 1922 it was the highest yielding wheat tested and averaged (in five separate plantings) 81.9 bushels to the acre or 40.9 sacks. A field planting has been made to provide seed for demonstrations in 1923. It has good milling quality, stiff tall straw, retentive chaff, and late maturity, and will probably succeed best when fall planted on moist bottom lands in northern California. The season of 1921–22 was particularly favorable to late maturing varieties.

Relative Yields of Races and Varieties of Indian Corn.—Of the seven varieties of Indian corn or maize employed in plant to row selection tests, as reported by J. F. Duggar, the average yield of husked ears to the plant of all strains of each was highest in the variety Pioneer. This is a white dent corn having large stalks, late maturity, and notable variation in type of ear.

In plot tests of races of corn the yield records made in 1922 at Davis by several varieties of soft corn and by one variety of popcorn challenged the usual superiority of dent corn. In this test of 19 varieties, representing the dent, flint, pop, sweet, and pod races, the largest yields to the acre were made by the following kinds, listed in the order of their yield:

Race—	Variety—	Pounds of husked ears to the acre
Soft	Blue-Purple Squaw (soft)	2250
Dent	Reid (dent)	2130
Soft	White Hopi (soft)	2010
Pop	Queen's Golden (pop)	1745
Soft	Navajo Mottled (soft)	1571

That three varieties of soft corn should have been among the five kinds leading in productiveness suggests the desirability of systematic improvement

of this neglected race by systematic plant-to-row breeding and by other methods of improvement of yield and type.

In a coöperative test of varieties furnished by the United States Department of Agriculture and conducted by V. H. Florell, the largest yields, listed in order of yield, were made by San Miguel, Hopi, Reid and U. S. Selection No. 133. The fact that a soft corn (white), Hopi ranked second in yield in this test, and third in the experiment previously mentioned, gives additional encouragement for the further testing and systematic selection of this and other varieties of soft corn that are thoroughly acclimatized to the heat and other climatic conditions of the southwest.

Relative Susceptibility of Races and Varieties of Indian Corn to Smut.—For all varieties of Indian corn grown at Davis in 1922, including the dent, flint, soft, pop, and pod races, determination was made by J. F. Duggar of the relative frequency and severity of boil smut on the ears. This disease was found on the ears of each of these races. The varieties showing the minimum amount of boil smut on the ears, together with yields above the average, were the two varieties of soft corn, Blue Hopi and Navajo White, as well as the dent varieties Mexican June, San Miguel, and Reid.

Fig. 23.—Hybridizing cereal varieties. A coöperative project with the U. S. Department of Agriculture at the Branch of the College, Davis. Practically all our best varieties of cereals are hybrids. The work of hybridization requires skill and pains and only a few crosses can be made during one season.

Some varieties were able to restrict the injury from smut to a few kernels near the point where the causative organisms were introduced. This restricted injury, or smut-limiting habit, was especially marked in the Blue-Purple Squaw, a soft corn, and in Queen's Golden popcorn. Their use as foundation stock or material for hybridization seems advisable if a variety is to be developed relatively resistant to smut and otherwise adapted to the climatic conditions of the Great Valley of California. Observations seemed to indicate that in 1922 the corn ear worm was one common means of conveying the smut organisms to the grains of corn.

Date of Planting Tests with Cream Cowpeas and Mung Beans.—In order to secure information on the effect of the time of planting on the growth and yield of seed P. B. Kennedy, B. A. Madson, and J. A. Denny conducted a test with Cream cowpeas and Mung beans at the Kearney Park Station in 1922. One plot of each was planted on the following dates: April 4, April 14, May 2, May 15, June 1, and July 3.

The stands on all the Mung bean plots were so badly damaged by army worms (*Prodenia proefica*) that no comparable data could be obtained. Only the last two plantings of the cowpeas, however, were affected. The highest yield of green material from the cowpeas was obtained from the planting of May 2, with 20.85 tons to the acre. The May 15 planting came next with 17.25 tons to the acre. The two April plantings, on the other hand, made a small, coarse, vegetative growth, yielding less than 9 tons to the acre.

The highest yield of seed was obtained from the May 15 planting, with 3843 pounds to the acre, while the planting on May 2 yielded 3481 pounds to the acre. The seed yields from the planting made on April 4 and 14 were 668 and 2729 pounds to the acre, respectively. The results show that early planting, while the soil and atmosphere are still cold, stunts the growth of cowpeas and greatly reduces both growth and yield.

Effects of Manure on Crop Growth.—On the dry land rotation experiments at Kearney Park, J. W. Gilmore and J. A. Denny have observed that it is becoming increasingly more difficult to secure good stands or growth, particularly of summer crops, on the land to which manure is applied. For the past ten years two three-course rotations of wheat, beans, and corn have been grown, the plots of one rotation receiving manure each year and the other receiving no manure. During the past three or four years particularly, the stand and growth of the corn and beans on the manured rotation have been very poor, many of the plants turning yellow and dying soon after they came up. The wheat has continued to make good yields, but the plants throughout the growing season have been much darker in color than those on the unmanured plots. Preliminary attempts to determine the cause of these conditions have indicated that it may be due to an excessive accumulation of nitrate in the soil. Samples of soil were taken on March 1, 1923, from the plots cropped to corn in 1922 and seeded to wheat in 1923, and analyzed by Hibbard. The plot which had been manured contained 700 parts to the million of nitrate in the surface foot of soil and 200 parts to the million in the second foot, while the plot which had received no manure contained 100 parts to the million of nitrate in each of the first and second feet of soil. On an adjoining plot, which had been fallowed during 1922, the nitrate content of the first and second feet was 250 and 200 parts to the million, respectively. But little alkali was present in any of the samples. Further studies will be necessary to verify these observations.

Spacing Test with Cream Cowpeas and Mung Beans.—A spacing test with Cream cowpeas and Mung beans, both of which have been promising legumes at the Kearney Park Station, was conducted by P. B. Kennedy, B. A. Madson and J. A. Denny at that station in 1922. The object of this test was to secure information on the effect which planting these legumes in rows of widths varying from 24 inches to 48 inches would have upon the total vegetative growth as well as upon the yield of seed.

In the test using cowpeas, the highest yields of green materials, 16.15 and 16.55 tons to the acre, were obtained from the closer plantings, there being little difference in yield between the 24- and 30-inch spacing. On the wider spacing, the yield of green material was considerably less. The production of seed was less consistent, for while the highest yield, 3358.47 pounds, was

Fig. 24.—A field of Onas wheat at the Davis Branch. This variety in plot trials at Davis in 1922 produced at the rate of 82 bushels to the acre, and in a field trial in 1923 produced at the rate of 110.4 bushels or 6624 pounds to the acre. When a superior variety of wheat is produced and proved, it is increased for distribution throughout the state in order to ascertain the conditions and locality where it does best.

obtained from the closer spacing, the second highest yield, 2703.07 pounds, was from the plot with rows 48 inches apart, the intermediate distances producing lower yields.

In the test with Mung beans, the closer spacing also gave the highest yield of green material to the acre, 16.70 tons, with a rather rapid decline with the increase in distance between the rows up to 42 inches. The 48-inch planting gave a larger yield, 14.25 tons, than the 36- and 42-inch plantings, these being 12.95 and 11.50 tons, respectively, but it was noted by Denny that the plants on the plot with rows 48 inches apart were coarse while those in the plots with rows 24 and 30 inches apart were fine. The results indicate that for maximum yield, as well as for the best quality of forage, the closer spacing should be employed.

For seed production the medium spacing of 36 inches gave the highest yield.

Experiments with Grain Sorghum in the Imperial Valley.—Grain sorghum, because of its adaptability to hot and irrigated regions, is an important crop in the Imperial Valley. To render the crop more certain and profitable, experiments were conducted by W. W. Mackie and L. G. Goar at the Meloland Experiment Station to determine the best varieties, spacing distances, and dates of seeding.

Variety Tests.—Twenty-one of the best grain sorghum varieties were sown in triplicate in plots of five rows each. The basis of comparative yield was made on the three center rows. The soil was hard and refractory, representing the poorer, harder soils of the valley. The behavior of these sorghums is reported as follows:

Fig. 25.—Texas Blue Grass in full Bloom. Berkeley Grass Gardens.

The Dwarf Milos and Feterita were the best producers of grain, but Dwarf Milo, CI–359, and Dwarf Milo, CI–332, at the head of the list, lodged very badly, approximately 50 per cent of the plants being flat on the ground at harvest. Dwarf Milo (Heileman), a strain selected by the late W. H. Heileman from the University Farm Milo in Glenn County, grew more evenly with heads more erect, than any of the other Milo. Spur Feterita produced well, but was inclined to shatter. Yellow Milo had an erect habit of growth, but lodged badly at harvest. White Yolo stood erect, but was inferior to the Dwarf Milos in yield. The percentage of grain in the heads varied from 70 in Blackhull Kafir to 89 in selected Milo.

In order of earliness in maturity, the varieties list as follows: Feterita, White Egyptian, Spur Feterita, Feterita Hybrid, White Yolo, Darso, and Eureka, maturing from 82 to 94 days from planting. The latest variety, Shallu, matured in 124 days.

Spacing of Rows and Plants in the Row.—To determine the best distance to space Dwarf Milo two sets of triplicated experiments were made, one set with the rows spaced from 2½ to 7½ feet apart, with plants uniformly spaced at 6 inches apart; and the other with rows spaced regularly at 3½ feet, with the

plants spaced in the row from 6 to 24 inches apart. Results based upon the three center rows of each set indicate that the best yields of Dwarf Milo on hard soils of the Imperial Valley are secured when the rows are spaced $4\frac{1}{2}$ feet apart and the plants in the rows separated by a distance of 6 inches.

Date of Seeding.—Dwarf Milo (Heileman) was seeded once a month, from April 15 to July 15, in very hard clay soil. The average yield for the triplicated series, varying from 1375 to 3572 pounds to the acre, indicate decisively that July 15 is the most favorable date for seeding Dwarf Milo in the Imperial Valley. This date favors the usual practice of planting grain sorghum after the barley or cantaloupe harvests.

Fig. 26—Rhodes Grass, an alkali tolerant plant at the Kearney Park Experiment Station

Varietal Adaptation of Oats.—Oats are frequently subject to stem rust attack in coastal regions and occasionally in interior areas. Droughts reduce yields in most regions of the state. W. W. Mackie reports comparative tests at Davis, Kearney Park, Los Angeles, and Meloland, under the rod-row system, with varieties selected from the experiments made in previous years:*

The tests for resistance to stem rust made with 17 varieties of oats indicate that several are highly resistant, but of these only the two strains of Richland, 281*a* and 320*a*, offer promise for California conditions. Burt 175*a* and Fulghum 257*a*, although possessing some resistance are likely to lodge. They are, however, among the very highest producers.

New hybrid oats and selections from 16 high-yielding varieties show marked differences in production depending upon the date of planting. For early sowing, Lachlan 8–C–9, Sunrise 2–C–8, White Big Algerian x White Tartarian 28–C–8, and Abyssinian are superior, but for late sowing, Fulghum, Abyssinian, Kanota, Sunrise 2–C–8, and Lachlan 28–C–9, appear well adapted. Sunrise 2–C–8, Abyssinian and Lachlan 28–C–9, are found to yield well whether sown early or late.

* Report of the College of Agriculture and Agricultural Experiment Station, University of California, 1920–21, p. 41.

Cotton Varietal Trials.—During the past year trials with 26 varieties of cotton have been conducted at Kearney Park, Fresno County, and at Meloland, Imperial County. Seed from pure stock is furnished each year by the Bureau of Plant Industry, United States Department of Agriculture. At Kearney Park, army worms, thrips, and red spider destroyed the crop. At Meloland, W. W. Mackie and L. G. Goar report that yields of all varieties except the Pima, Ideal, Triumph, and Cleveland were reduced from 25 to 50 per cent by the ravages of the leaf miner (*Bucculatrix thurberiella*). While only the ribs of the leaves remained in all other varieties, only 25 per cent of the leaf surface of the Pima plants were skeletonized, and approximately 25 per cent of the Ideal, Triumph, and Cleveland varieties.

Fig 27.—Legume Garden at the Branch of the College at Davis. A large number of varieties of legumes are grown at Davis, Kearney Park, Berkeley, and Meloland for the purpose of finding the best for forage, seed and cover crops. Other technical studies are being made on these varieties.

According to E. O. Essig, this insect feeds naturally upon a cotton-like plant (*Thurberia thespesioides*) which is indigenous to the arid southwest. For the past three years its ravages on cotton in the Imperial Valley have rapidly increased until many hundreds of acres were attacked. The insect can be controlled by thoroughly dusting the leaves with lead arsenate as soon as the first miners appear. A second dusting may be necessary.

Owing to the small difference between the price of the long staple Egyptian varieties and the high yielding big ball, short staple varieties, no long staple cotton is now grown in the Imperial Valley. The selection and improvement of the latter type is therefore important.

The Surviving Plant Method of Selecting Bunt-Resistant Strains Within a Variety of Wheat.—Many hundreds of varieties of wheat have been subjected to bunt (*Tilletia tritici*) attack in the past six years in order to determine the

specific resistance of each variety. Even with those varieties which were most susceptible, some plants escaped bunt attack, as determined by examination of the grain at harvest. Seed from every plant which escaped attack were smutted and sown in a rod-row. Only those selections which showed improvement in resistance were continued. This process is called the "surviving plant method."

Earlier work* resulted in the selection of a strain practically immune from bunt attack, Galgalos, a high yielding spring variety grown in certain regions of California. Continued experiments by W. W. Mackie and F. N. Briggs with spring wheats possessing considerable resistance to bunt resulted in nearly every case in the selection of strains decidedly more resistant to bunt than the original parent.

Fig. 28.—View of part of Legume Nursery, Kearney Park Experiment Station, May 4, 1923.

With those varieties of wheat which possess one or more factors for resistance to bunt, the surviving plant method may offer a means of increasing resistance to bunt in otherwise desirable varieties without resorting to the tedious and more or less uncertain method of securing resistance by crossing with bunt immune varieties.

Breeding for Resistance to Bunt.—In order to secure immunity or resistance to bunt attack, crossing a susceptible variety of wheat with an immune variety offers a promising solution. Over 1000 varieties of wheat were tested for resistance to bunt (*Tilletia tritici*) at Davis by W. W. Mackie and F. N. Briggs. From these were secured immune strains of two red winter wheats, Martin Amber and Red Hussar, and one spring wheat (Galgalos). Hybrid seed furnished by V. H. Florell from crosses in breeding the two immune strains of winter wheats gave in the first or F_1 generation results which indicate that bunt resist-

* Report of the College of Agriculture and Agricultural Experiment Station, University of California, 1921–22, pp. 25–26.

ance is dominant in crosses between highly susceptible and immune wheats. For example, early Baart, 1697, parent, giving a plant count of 83.5 per cent bunt attack when crossed with Red Hussar, 4843, parent, immune to bunt attack, gave 0.8 per cent plant count of bunt attack.

Grass Garden.—The Grass Garden on the University grounds at Berkeley, in charge of P. B. Kennedy and in coöperation with the Departments of Cereal and Forage Crop Investigations of the United States Department of Agriculture, continues to serve a very useful purpose. Many investigators in this and other states rely upon us to supply them with seed for their studies of grasses as host carriers for the rusts of cereals. Surplus seeds distributed to foreign countries have proved of value to investigators seeking to improve their forage conditions. An example may be cited in the case of *Melica californica*, one of our native grasses which has been found well adapted to Tasmania. Numerous lots of seed and sacks of roots have been distributed to farm advisors and others in this state who are interested in forage improvement. Physicians and others interested in the relation of the different kinds of pollen to hay fever frequent the garden at all times. The Cutter Laboratories, which desire authentic material for the distribution of specific pollen, have made extensive use of the garden and find the method of naming the grasses with distinct labels of great value to them.

The plots of turf-forming species have been visited by many representatives of golf clubs who desire information as to the best type of grass for their putting greens and fairways.

Harding grass (*Phalaris stenoptera*), Smilo grass (*Oryzopsis miliacea*), Kikuyu grass (*Pennisetum clandestinum*), Texas blue grass (*Poa arachnifera*), and Rhodes grass (*Chloris gayana*) continue to be regarded with favor by the farmers and are being grown to a considerable extent for pasture or range purposes. Blue joint (*Elymus triticoides*) and Reed Canary grass (*Phalaris arundinacea*) will prove valuable as soon as seen can be obtained in commercial quantities. A new grass, closely related to Harding grass and similar in vegetative and floral characteristics, is *Phalaris truncata*. It proves superior to Harding grass as a winter grower in the Grass Garden at Berkeley. Other species which are promising for forage are *Elymus glaucus, Bromus unioloides, Danthonia californica, Stipa pulchra, Chaetochloa nigrorostris, Panicum antidotale. Melica californica, Bromus sitchensis, Agrostis verticellata, Koeleria cristata, Festuca arundinacea* (form), *Paspalum dilatatum*, and *Andropogon intermedius*. Two ornamental grasses that should be introduced into the trade are *Ampelodesmos tenax* and *Chloris distichophylla*. New sandbinding species are *Saccharum spontaneum* and *Agropyron junceum*. For the forming of a fine dense turf for putting greens, several forms of *Agrostis stolonifera* and *Agrostis canina* have given the best results.

Legume Nurseries.—Nurseries for preliminary trials in rod rows of legumes for forage and green manure have been continued during the past year at the following places: Berkeley, Kearney, near Fresno; Meloland, in Imperial Valley, and at the University Farm, Davis.

The following proved worthy of more extended investigations: Hubam clover, *Lotus corniculatus, Medicago lupulina, Trigonella coerulea, Trifolium alexandrinum, Trifolium repens* var. *latum, Lupinus albus* and *L. succulentus, Phaseolus aureus, P. aconitifolius, Lathyrus tingitanus, L. clymenum, L. sativus, Vicia faba* var. *minor, Crotalaria madurensis, Vicia ervilia,* and *V. monanthos.*

The extent of the trials at Kearney may be indicated by stating that there were 50 rod rows growing all the different vetches, 14 to *Melilotus*, 67 to *Medicago sativa*, 23 to *Vigna sinensis*, 30 to *Soja max*. All the well-known legumes, as well as many new ones not heretofore grown in the state, were represented. Some of the legumes worthy of note are as follows: Hairy vetch (*Vicia villosa*), Woolly podded vetch (*V. dasycarpa*) and Purple vetch (*V. atropurpurea*), which have proved superior to common vetch (*Vicia sativa*); Hungarian vetch (*V.

Fig. 29.—The Mung Bean, *Phaseolus aureus*, Kearney Park Experiment. Station, August 12, 1923. A new summer crop.

pannonica), and Narrow leaved vetch (*V. angustifolia*). Tangier Pea (*Lathyrus tingitanus*) made a good growth from the early fall sowings, but made little growth during the winter if sown late. Blue flowered fenugreek (*Trigonella caerulea*) made the best erect winter growth at Davis and Kearney. *Melilotus tomasina* was the best of the *Melilotus* species for growth during the cold weather. A variety of *Pisum sativum* No. 218, a field pea with purple flowers, gave much promise as a winter cover crop.

The Mung bean (*Phaseolus aureus*) will be found valuable as a summer crop for forage or as a green manure for several reasons. The seed is small requiring only 4 pounds to the acre. It germinates readily, coming up in four days in

moist soil. The leafage is palatable and the tonnage of green stuff is as great as any of our summer legumes. The plant attains a height of 3 to 4 feet and grows erect.

The Moth bean (*Phaseolus aconitifolius*) is considered by orchardists to be just the plant they are looking for, as it creeps along the ground and does not obscure the irrigation furrows.

Berseem clover (*Trifolium alexandrinum*).—Experiments with Berseem clover were begun by P. B. Kennedy in October, 1921. Since that time extensive plantings have been made in the Imperial Valley with the coöperation of W. W. Mackie and L. G. Goar. Small plantings at Berkeley, Kearney, and Davis indicate that it will grow under a wide range of climatic conditions. It has

Fig 30—Harding Grass pasture at the Davis Branch

withstood the winters in all four places, indicating that it is much more frost tolerant than is generally supposed. Berseem takes the place of alfalfa in Egypt and is utilized extensively there for hay, pasturage, and soiling. It is alkali tolerant to a considerable degree and may also be grown on land which has a comparatively high water table. Being an annual, it does not present the difficulties in destroying the root system, as does alfalfa. It is also a valuable green manure crop for truck gardeners. Several cuttings and a seed crop may be obtained in a single season if the crop is planted as early as October 1. Good seed has been produced at both Berkeley and Imperial Valley, a range of climate sufficiently variable to indicate that California should have no difficulty in supplying its own seed.

Date of Seeding.—In order to determine the effect of the date of seeding upon the yield four plots of one-eighth acre each were planted in triplicate

and were irrigated once a month. Plantings were made at intervals from October 5 to November 18 and the crop cut three times for hay and then permitted to go to seed. These trials by W. W. Mackie and L. G. Goar at Meloland indicate that Berseem should be sown as early as conditions permit, or about September 1, so as to secure early growth before cold weather sets in. The earliest planting produced the highest yield, 3104 pounds to the acre. The more mature plants withstood the frosts much better than late sown tender plants. Earlier seeding encouraged increased tillering and deeper rooting. As this plant roots deeply and strongly an early start is desirable. The crops were cut when a growth of 20 inches was reached. At this time the plants had reached their maximum height for the heavy soils of the station. Nodules appeared in abundance on all plants.

Rate of Seeding.—In order to determine the proper quantity of seed of Berseem to sow in the Imperial Valley, plots were seeded and irrigated on November 2, at four different rates: 10, 15, 20, and 25 pounds to the acre.

Although the results indicate that ten pounds of seed to the acre gives the best yield (2528 pounds), it was evident that the stand was somewhat too thin, permitting weeds to grow. On the other hand, where the rate of seeding was too heavy, the plants were smaller and the total yield reduced. An average rate of fifteen pounds to the acre appears best.

Irrigation of Berseem.—Berseem plots were sown on November 2 at the rate of 15 pounds to the acre, irrigated at intervals of one, two, three, and four weeks, and mowed on March 15. The highest yield was obtained from the plot irrigated at intervals of two weeks. It should be noted, however, that this plot was quite weedy. Furthermore, the plots which were irrigated at one and two week intervals became a sickly yellow in color, while those irrigated at three and four week intervals presented the normal dark green color of Berseem. Apparently no beneficial results were secured by irrigating Berseem oftener than once a month. On the softer soils, even less frequent waterings may be satisfactory.

Demonstration plots of Berseem on farms with softer soils than those of the station indicate that 5 or 6 crops may be produced from September or early October seeding. Berseem cut and fed green to dairy cattle produced milk excellent in both quantity and quality and was far less likely than alfalfa to cause bloating.

Berseem mowed on March 14 showed an average growth of 24 inches exactly 21 days later. While Berseem is essentially a soiling crop, it may be pastured to advantage if the stock are staked out or are placed on it for brief rotated intervals. The hay from Berseem is excellent and highly palatable to stock.

Horse Beans.—The experiments with horse beans are being continued along the lines reported in Circular 257 of this Station to determine how small the seed may be reduced by selection without lessening the yield of green weight to plow under as a cover crop. Numerous plants are being grown as individuals with a view of selecting those producing the smallest seeds.

Rice Weeds.—In addition to the work reported in Bulletin 356 of this Station, a systematic study has been made by P. B. Kennedy and L. Mah of the water grasses (*Echinochloa*) which occur in California. The following species have been identified.

Echinochloa colonum	Meloland
Echinochloa frumentacea	Adventive, Casa Desierto
Echinochloa crus-galli	Common throughout state
Echinochloa crus-galli longiseta.	Biggs, Cortena, Willows, and rice region generally
Echinochloa muricata	Cortena
Echinochloa walteri	Grass Garden only

Studies in Wild Oats (Avena).—Investigations have been made by P. B. Kennedy and V. H. Florell, a graduate student, to determine what species, sub-species, and varieties of wild oats occur in the state. The cultivated oats of the section (*sativae*) are distinguished from the wild forms by their obsolete or usually short straight or weakly geniculate awns and by their glabrous lemmas. The following wild species and varieties have been identified:

Slender wild oats	*Avena barbata*
Common wild oats	*Avena fatua*
Smooth common wild oats	*Avena fatua glabrata*
Animated wild oats	*Avena sterilis*
Large-seeded Animated wild oats	*Avena sterilis macrocarpa*

The first two, *A. barbata* and *A. fatua*, are the most abundant in the state and seem to occur in about equal proportions. The slender wild oats extend into less fertile soils than the common wild oats. Both species are to be regarded as valuable range plants.

Fig. 31.—Grand Champion Steer Herd—International Livestock Exposition, Chicago, Ill., 1922. Reading from left to right, California Standard, California Bystander, and California Standard 2nd.

ANIMAL HUSBANDRY

Breeding Herd of Beef Cattle.—The breeding herds of beef cattle used in class work and demonstration consist of 14 Aberdeen Angus, 17 Hereford, and 31 Shorthorn females of all ages. While this number, except in Shorthorns, is not adequate to furnish suitable groups for class work, it will be necessary to reduce the herd materially on account of lack of facilities in order to make possible proper care both during the pasture season and during the time when shelter is necessary. The herd has been placed under Federal supervision on the accredited herd plan for the eradication of tuberculosis. The first test has revealed no reactors.

Notable Aberdeen Angus Cow.—The Aberdeen Angus cow, Oakfield Lula, a member of the purebred herd at the University Farm since its establishment, has achieved the distinction of being a greater contributor of prize winning steers to the International Live Stock Exposition at Chicago than any other cow of any breed. Her first son, U. C. Jock, was grand champion steer at the Panama-Pacific Exposition in 1915 and the following year won the championship for his breed and the reserve grand championship of the show at Chicago. U. C. Jock 3d as a calf was reserve grand champion in 1919. The 1921 grand champion, Lula Mayflower, was out of a daughter of this cow, and the three steers composing the grand champion steer herd of 1923 were her grandsons.

Range Cattle Experiment.—The number of cattle included in the range experiment* at Shingle Springs at the close of this year is 227 cows, including yearling heifers, and 30 yearling steers. Feed on the leased ranches during the past season has been what is considered normal for the first time in the three years of University control. The herd has been reduced to the carrying capacity of the range, and both cattle and range furnish a demonstration of that satisfactory condition resulting from conservative management. This fact is recognized by neighboring stock men.

At the University Farm are 30 cows, 42 yearlings, and 26 calves. The cows are to be sold when calves are weaned. The yearlings and calves will be put on feeding trial planned to show relative gains on alfalfa pasture.

Feeding Trials with Calves.—The work of the past two years in studying economical practices of preparing range cattle for the market, involving the feeding of calves, yearlings, and two-year-olds, has been continued† during the year 1922-23. The thirty-four animals used in the first trial were brought down as calves from the Shingle Springs range on November 26, 1921. During the month of December they were on alfalfa pasture where they gained an average of 2.12 pounds a day. On account of excessive rains, however, it was necessary to remove them to a pasture where the volunteer feed was not well started. They gained during January, therefore only 0.29 pound a day. They were then changed to a field which had fairly good volunteer feed and where they gained 0.46 lb. and 0.56 lb. a day for the months of February and March, respectively. When put on alfalfa pasture again, they gained 1.74 lb., 2.83 lb.,

* Report of the College of Agriculture and Agricultural Experiment Station, University of California, 1921–22, p. 54.

† Report of the College of Agriculture and Agricultural Experiment Station, University of California, 1921–22, pp. 54–55.

and 2.25 lb. a day for the respective months of April, May, and June. During the month of July, the alfalfa became badly injured by grasshoppers, and the animals gained only 0.43 lb. a day; on July 28 they had to be put on feed in a dry lot.

Feeding Trials with Steers vs. Heifers.—The animals were divided into two groups with 19 steers in Lot I and 14 heifers in Lot II, in order to make a study of the difference between steers and heifers. Lot I made total gain during the period from July 28 to October 27 of 197.79 lbs. or an average daily gain of 2.19 lbs. Lot II, during the same period and with 2.36 lbs. less of the daily ration which consisted of alfalfa hay, barley, and cottonseed meal, made a total gain of 203.78 lbs. or an average daily gain of 2.26 lbs. At the end of the trial the steers were sold for $8.50 the cwt. and the heifers at $6.50 the cwt.

Fig. 32.—Choice range steers fed at the University Farm. Picture taken at the close of feeding period, October 27, 1922. The steers are the result of crossing ordinary range cows with pure-bred bulls.

Two-Year-Old Steers vs. Yearlings.—Twenty-seven yearlings and 22 two-year-old steers were brought down from the Shingle Springs range and placed on feed November 23, 1922. Both lots were fed on a ration of barley, cottonseed meal, alfalfa hay, and sorghum silage for 120 days. The yearlings, consuming a daily feed of 44.47 lbs., made a total gain of 276.75 lbs. or 2.3 lbs. daily, while the two-year-olds upon 51.65 lbs. of feed daily made a total gain of only 224.09 lbs. or of 1.86 lbs. daily. Both lots were sold at the end of the feeding trial for $7.25 the cwt. They were weighed out of the lot on full feed with a 3 per cent shrinkage.

The Dairy Herd.—During the past year facilities for handling the dairy cattle at Davis have been much improved. A covered yard adequate for the sheltering of the milking herd has been added to the milking barn. A comprehensive drainage system for the dairy corals has been established. Some paving has been laid in a part of the lots. The health of the herd has been good, the greatest loss arising from difficult breeding on the part of some of the best cows. Some land has been set aside for dairy pasture; and it is hoped

Fig. 33.—Constructive Breeding—the Agnes Family, all bred by the University of California. Left to right, Agnes Colantha, the foundation cow—lifetime production 86,426 pounds of milk and 2983 pounds of butter fat and her descendents; California Agnes Colantha, a daughter, produced in one year 26,205 pounds of milk and 982 pounds of butter fat; California Colantha Agnes, another daughter, whose yearly production at three years of age was 21,665 pounds of milk and 725 pounds of butter fat; California Juliana Agnes, another daughter who produced as a two year old 17,044 pounds of milk and 637 pounds of butter fat; Sir Juliana Agnes Colantha, a son; Sir Aaggie De Kol Agnes, a grandson; California Aaggie Acme Agnes, another daughter.

Fig. 34.—California Agnes Colantha. Record for one year, 26,205 pounds of milk and 982 pounds of butter fat.

that with ample exercise and an abundance of green feed that this condition will be largely obviated. The herd has been placed under Federal supervision for the accredited herd plan of tuberculosis eradication. The first test resulted in four reactors. During the coming year active measures will be taken to establish a herd free from abortion as well as from tuberculosis.

The inventory of the herd on June 30, 1923, shows a total of 136 animals, 115 pure-breds and 21 grades, distributed as follows:

	Jersey	Holstein	Ayrshire	Guernsey	Grades
Females over 2 years	31	13	6	4	12
Females under 2 years	24	10	8	1	9
Bulls	8	7	1	2	0
Total	63	30	15	7	21

Fig. 35.—Type and production combined. Pietertje Lorena Korndyke. Bred by University of California. Production 96,335 pounds of milk and 2940 pounds of butterfat.

Approximately 30 typical representatives of each breed are required to take care of the demands for class work. This point has been reached in the development of the Holstein and Jersey herds, the latter considerably exceeding that figure with the recent additions of 30 animals in the breeding experiment. Two foundation females were added to the Guernsey herd during the past year. Through the liberality of Ayrshire breeders, four Ayrshire heifers were added to the herd. The following breeders each donated an animal: Selah Chamberlain, Redwood City; J. W. Hanner, Sacramento; C. A. Le Baron, Valley Ford; and Mrs. Beatrice M. Ganz, Santa Barbara.

The average daily production of each cow in the milking herd throughout the entire year was slightly in excess of 31 lbs. of milk and 1.25 lb. of butter fat.

Advanced Registry of Cows Bred and Owned by University Farm.—Nineteen advanced registry records were completed during the year at Davis. Of these, twelve were 365-day records; four were 305-day records; and three were 7-day records. California Pietertje Bloom Mead No. 450151, a Holstein, 4 yrs. 1 mo. old, holds the State Championship for Junior four-year-olds, producing 28,236.1 lbs. of milk and 1,004.62 lbs. of butterfat. Another commendable record in the 365-day test was that of California Colantha Agnes No. 501722, a Holstein, 5 yrs. 5 mo. old which produced 21,665 lbs. of milk and 725 lbs. of butterfat. California Owl's Nora, No. 388368, a Jersey, 4 yrs. 6 mo. old, produced 11,222 lbs. of milk and 638 lbs. butterfat in 365 days, thus becoming State Champion of Senior four-year-olds. California Pietertje Bloom Mead No. 450151, produced during seven days 623 lbs. of milk and 25 lbs of butterfat.

Fig. 36.—California Pietertje Bloom Mead. Bred by the University of California. She produced in one year 28,236 pounds of milk and 1004 pounds of butterfat. State Champion junior four-year-old.

Supervision of Advanced Registry.—The supervision of advanced registry tests is a service rendered by the University to the breeders of pure bred dairy cattle. If the results of these tests are to be of value to the breeders, the supervision must be careful and painstaking. As a result of the expansion that has taken place in the past few years, a great amount of work is required to carry on this supervision efficiently. The number of separate tests supervised during the year was 6528. Of this number 6084 were on 365-day tests and represented five breeds, distributed as follows: Holstein, 4221; Jersey, 1129; Guernsey, 488; Ayrshire, 177; and Shorthorn, 93. The remaining 444 were Holsteins on 7- and 30-day tests. The total number of breeders testing was 104, while the total number of supervisors employed was 19.

The following state records, in addition to those made by cows bred and owned by University of California and mentioned in the preceding section, were made during these tests: The record for Jersey junior three-year old was made by Lydia's Valentine (Dr. Gross), producing 9413 lbs. of milk and 606.58 lbs. of butter fat; for the Jersey senior three-year old by Raleigh's Fairy Gussie (Dr. Gross), producing 13,679 lbs. of milk and 667.33 lbs. of butter fat; for the Jersey two-year old by Valet's Jannette (Grant Brown), producing 9695 lbs. of milk and 610.32 lbs. of butter fat. Two additional Holstein records also were made: one by Woodbine Rosa Prilly (Bridgford-Holstein Co.), a junior two-year old, producing 26,759.6 lbs. of milk, and the other by Lady Veeman Happy Thought (Earl Graham), a senior three-year old, producing 17,492.4 lbs. of milk in 305 days.

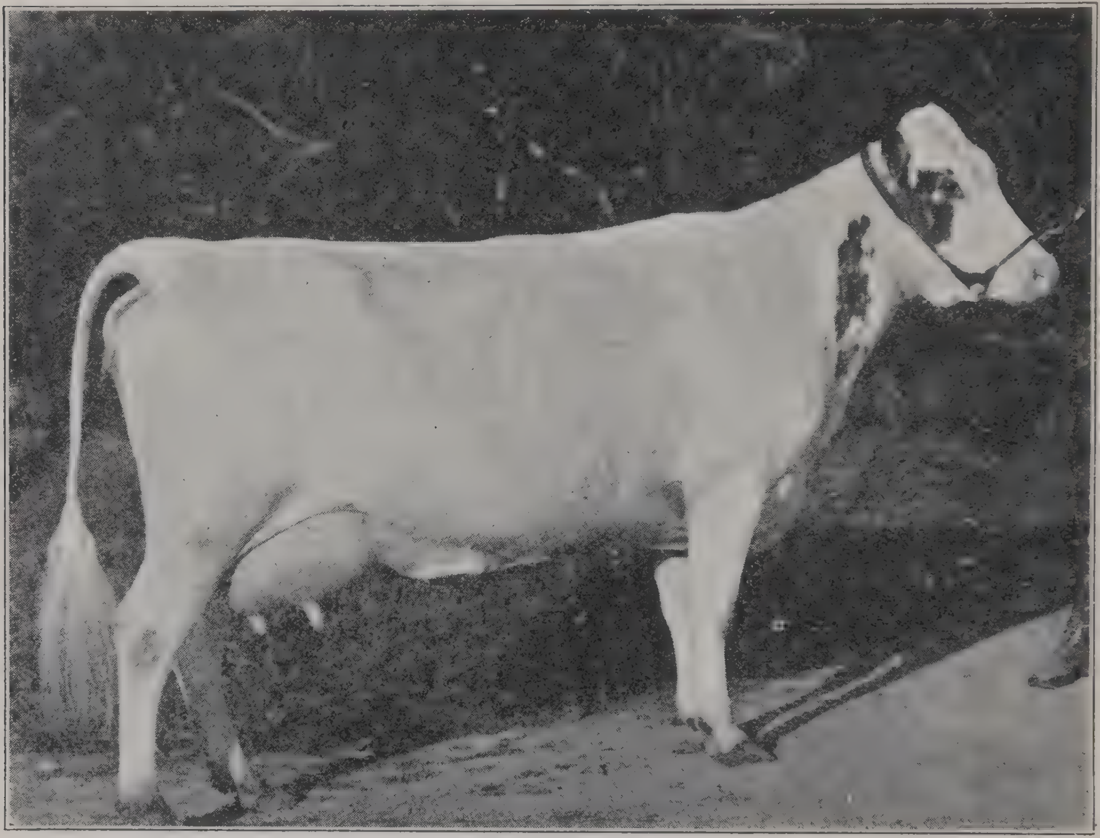


Fig. 37.—A beautiful Ayrshire—California Barcheskie II. Bred by University of California. Record for one year, 12,956 pounds of milk and 597 pounds of butterfat. Class leader for college-owned Ayrshires.

Several changes in supervision were made: Preliminary milking was adopted for all breeds. Taking of composite samples was discontinued, and an affidavit blank covering all rules for conduct of the tests was adopted. The practice of allowing cow-testing association testers to supervise advanced registry testing for members of their respective associations was discontinued.

Breeding Experiments; In-breeding vs. Out-Crossing.—This is one of a series of experiments which have for their purpose the determination of that method of breeding that will best fix and insure the transmission of high production in dairy cattle. To measure the relative efficiency of these two methods, the following data are being taken:

1. Production:
    - *a.* Pounds of milk.
    - *b.* Per cent of fat.
    - *c.* Pounds of fat.
2. Size and Development:
    - *a.* Body weights taken monthly from birth.
    - *b.* Height at withers taken monthly from birth.
3. Constitutional Vigor:
    - *a.* Heart girth measurement taken monthly from birth.
4. Reproduction and Breeding:
    - *a.* Size and vigor of calves.
    - *b.* Age at sexual maturity.
    - *c.* Sterility.
    - *d.* Susceptibility to abortion.
    - *e.* Sex ratios.
5. General Conformation:
    - *a.* Recorded by pictures.

Fig. 38.—The Nora Family. Left to right: California Owl's Nora—11,222 pounds of milk and 638 pounds of butter fat; State Champion senior four year old. California Japs Nora, 10,528 pounds of milk and 546 pounds of butter fat. Meridales Jap Nora, 13,495 pounds of milk and 644 pounds of butter fat.

Data have been taken on a herd of pure-bred Jerseys at the New Jersey Experiment Station. This herd comprising 33 head with all accumulated data has been purchased by the University and is now at Davis where the experiment is being continued. The New Jersey Experiment Station and the Dairy Division of the United States Department of Agriculture are carrying on similar experiments comparing line-breeding to out-crossing.

Normal Growth of Dairy Animals.—In order to determine a definite growth standard for dairy animals of different ages, body weights and height measurements are being taken on all animals in the dairy herd monthly.

The Nutritive Value of Sunflower Silage for Dairy Cows.—During the past winter a second feeding trial with dairy cows in the University dairy herd was conducted by F. W. Woll, W. E. Tomson, and M. A. Haney, in which the relative value of sunflower silage and corn silage for dairy cows was studied. The experiment was conducted in the same manner as the first feeding trial.[*]

Report of the College of Agriculture and Agricultural Experiment Station, University of California, 1921–22, p. 58.

Silage was made from sunflowers when the seed had reached the dough stage. The moisture content was 74.2 per cent, of which 1.59 per cent was fixed acid and 14 per cent volatile acid. The cows consumed an average of 18 pounds of sunflower silage daily, against 25 pounds of corn silage. The results of this feeding trial indicate that sunflowers cut when the seeds are in the dough stage make a more palatable silage than silage from sunflowers cut at early bloom.

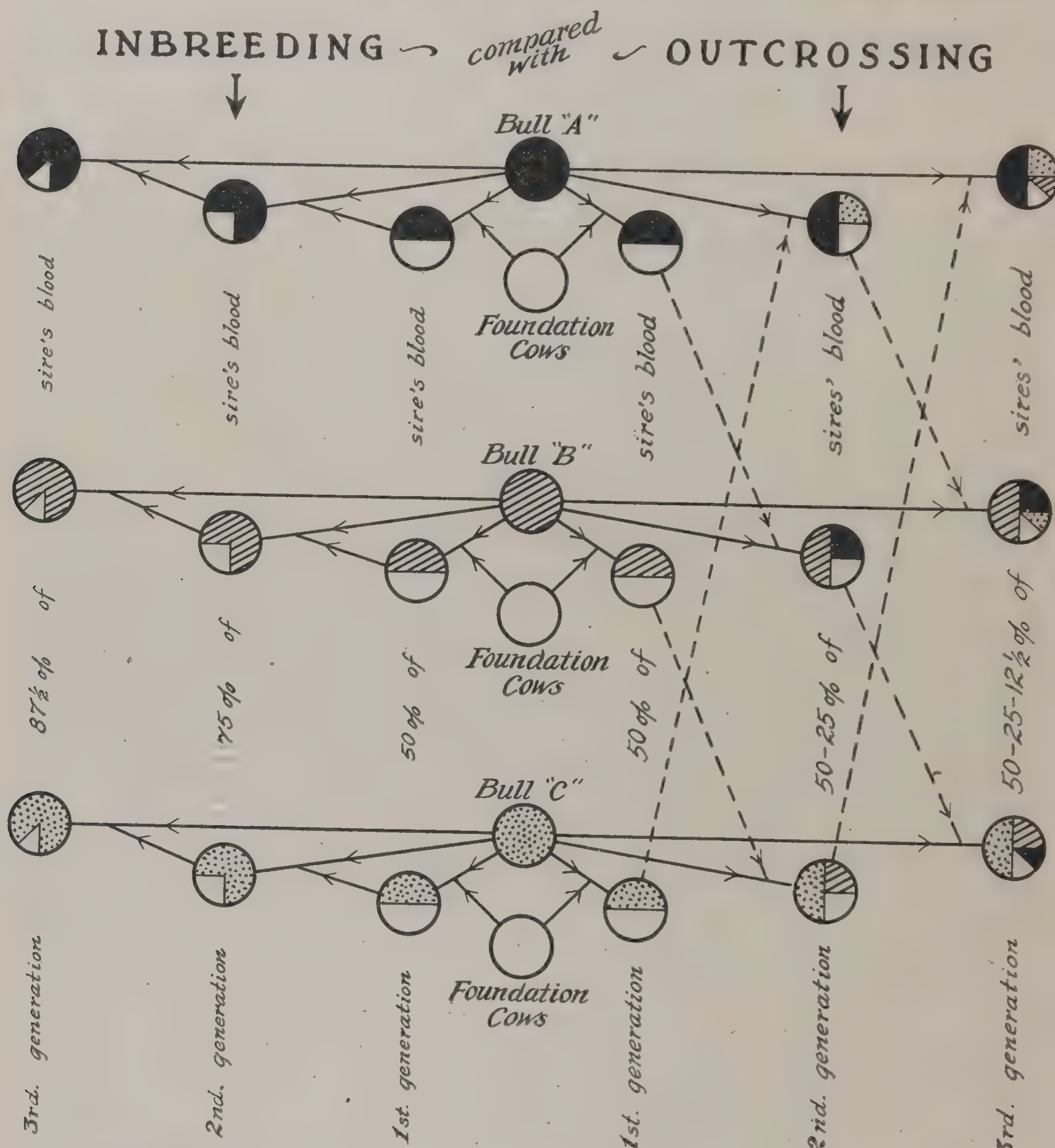


Fig. 39—The chart above shows the method of breeding followed in inbreeding and out-crossing the dairy cattle

The Nutritive Value of Orange Pulp for Dairy Cows.*—F. W. Woll conducted a preliminary experiment at the Pellissier Ranch near Whittier during the summer of 1922 feeding orange pulp to a large number of milking cows for a period of three months. The results indicated strongly that the pulp feeding effected an increase in the fat content of the milk. This increase in the per-

* The chemical analysis of organic by-products as made by M. E. Jaffa may be had upon request from the Division of Animal Husbandry, Davis.

centage of fat in the case of individual cows was frequently as much as 0.5 per cent, and in extreme cases over 1 per cent. Experiments are planned to furnish further and more conclusive evidence on this point.

Sheep.—The breeding flock of sheep consists of about 135 mature ewes; namely, 26 Rambouillets, 26 Hampshires, 30 Shropshires, 33 Southdowns, 17 Romneys, and 3 Cheviots, besides 150 head of lambs. These are used for class and experimental work, including a study of the birth weights of twins, singles, rate of subsequent gain of the different breeds, as well as for problems in wool production.

Fig. 40.—Southdown wether lamb, bred, fed and exhibited by the University of California. Grand Champion Wether at the Pacific International Livestock Exposition at Portland, the American Royal Livestock Show at Kansas City, and the International Livestock Exposition at Chicago.

Feeding Trial.—In order to study the comparative feeding value of various roughages, 192 lambs were fattened for market during the past winter. The lambs were mostly cross-bred Lincoln Rambouillet and were divided into four lots. Lot I, 47 lambs, received a daily ration of 0.745 lb. of barley and 3.61 lbs. of bean straw; lot II, 46 lambs, received 0.815 lb. of barley and 2.93 lbs. of cut alfalfa hay and cut barley straw; lot III, 47 lambs, received 0.727 lb. of barley and 2.84 lbs. of cut alfalfa hay; and lot IV, 48 lambs, received 0.724 lb. of barley and 2.64 lbs. of whole alfalfa hay.

The ration consisting of cut barley straw and cut alfalfa hay, 50 per cent of each being used, was mixed and run through the ensilage cutter together. The cut alfalfa hay was chopped into pieces 1 to 1½ inches long.

1. The cut alfalfa hay and whole alfalfa hay rations were found to be superior to the other roughage rations, giving an average daily gain of 0.294 lb. and 0.22 lb. as against 0.193 lb. and 0.197 lb. for the bean straw and alfalfa hay, and barley straw rations, respectively.

2. The bean straw, a coarse and inferior roughage which can be used to advantage only when fed directly from the stack, was also found to be quite laxative. No doubt the ration would be improved by mixing it with some other roughage.

3. The whole alfalfa hay proved decidedly superior to the cut alfalfa hay. The cut alfalfa hay was probably chopped too coarse, as the sheep refused a large portion.

4. The cost of each 100 pounds gained was decidedly less in the case of the whole alfalfa hay, being only $8.10 as against $10.68 for cut alfalfa hay, $14.26 for the cut alfalfa hay and cut barley straw, and $11.94 for the bean straw.

Fig. 41.—Flock of sheep at the University Farm, including Rambouillet, Hampshire, Shropshire, Southdown and Romney.

Advanced Registry for Rambouillet Sheep.—The Division of Animal Husbandry has undertaken the supervision of the advanced registry of Rambouillet sheep on the basis of wool production, under a system of rules and regulations prepared by the California Rambouillet Sheep Breeder's Association.

Fifty-two registered Rambouillet ewes and rams belonging to five breeders have been entered for advanced registry. Official scouring tests to determine the eligibility of these sheep to advanced registry is being carried on at the wool laboratory of the Animal Husbandry Division.

Tests are being made to determine the difference in the yield of scoured wool from sheep shorn once a year as compared with that from sheep shorn twice.

Data recorded during the past year emphasize the correlation existing between length of staple and fineness of wool fibers. The data indicate that the surest and perhaps the quickest way to increase the length of staple of finewool sheep is through the use of rams having comparatively coarse fleeces.

Birth weights of lambs and weights of yearling ewes have been recorded.

Ram Sales.—The annual ram sale held at the University Farm under the auspices of the California Wool Growers' Association has become an important

event and has resulted in the distribution of a large number of high class pure bred and registered rams throughout California. Members of the Animal Husbandry staff have been active in the fostering and management of the various sales.

At the first sale held in June, 1920, about 300 head were sold; at the second, June 1921, about 320 head; at the third, June, 1922, about 370 head; and at the fourth, May, 1923, about 700 head.

Approximately 300 rams were consigned at the last sale by breeders from other states, and the general average for the entire sale was $50.00 a head. It is gratifying to see the interest in "better rams" which is being stimulated by these sales.

The early spring lamb development throughout California during recent years has also greatly stimulated the use of better sires, as the majority of these lambs are shipped to eastern markets where "quality" is in demand and where only the well-bred lambs realize the highest values.

Feeding Rice and Rice By Products to Swine.—E. H. Hughes and B. H. Thomas have obtained additional information* concerning the feeding of rice and rice by products to swine being fattened in the dry lot. In the test begun June 9, 1922, and concluded September 9, 1922, eight lots of pigs were fed the following rations:

Lot I. Rolled barley and tankage, self-fed in separate self-feeders.
Lot II. Brewers' rice and tankage, self-fed in separate self-feeders.
Lot III. Rolled barley, rice polish and rice bran (equal parts by weight) mixed and fed in self-feeder.
Lot IV. Rolled barley and rice polish (equal parts by weight) mixed and fed in self-feeder.
Lot V. Rolled barley and rice bran (equal parts by weight) mixed and fed in self-feeder.
Lot VI. Rolled barley and rice polish (equal parts by weight) mixed and fed in self-feeder, plus tankage in separate self-feeder.
Lot VII. Rolled barley and rice bran (equal parts by weight) mixed and fed in self-feeder, plus tankage in separate self-feeder.
Lot VIII. Rice Paddy and tankage, mixed in the proportion of 9 parts rice paddy to 1 part tankage, by weight, cooked for 12 hours and hand-fed twice daily.

The pigs used in the test were pure-bred Poland Chinas and Duroc-Jerseys, farrowed in March and April, bred and raised at the University Farm, and divided as uniformly as possible into eight lots with ten pigs in each lot. Lots IV and V finished with nine pigs in each lot. One pig in lot IV had to be removed on account of sickness on June 16, and one pig in lot V died August 30.

Those lots which were not fed tankage made comparatively slow gains averaging less than a pound a day. The amount of feed consumed by these lots for each 100 pounds of gain was relatively higher than in those lots where tankage was fed.

Satisfactory daily gains were made by the pigs in lots I, II, VI and VII. The most rapid gains were made by those in lot II. They were fed Brewers' rice and tankage. Gains in this lot were made on a comparatively small amount of feed.

* Report of the College of Agriculture and Agricultural Experiment Station, University of California, 1921–22, p. 56.

In lot VIII where rice paddy and tankage were fed in the proportion of 9 parts of rice paddy to 1 part of tankage, by weight, fed cooked, daily gains were small, and moreover considerably more feed was required to produce 100 pounds of gain in lot VIII than in the other lots. The pigs did not do well on this feed.

Feeding Paddy Rice.—On January 16, 1923, an experiment was begun to determine the feeding value of damaged and undamaged rice paddy when finely and coarsely ground. Two lots of pigs were fed barley as check lots.

Six lots, with twelve pigs each, were self-fed in the dry lot—tankage being used as a supplement in each case. The trial was concluded April 3, 1923.

The rations fed were as follows:

Lot I. Rolled barley and tankage.
Lot II. Ground barley and tankage.
*Lot III. Coarsely ground undamaged rice paddy and tankage.
Lot IV. Finely ground undamaged rice paddy and tankage.
Lot V. Coarsely ground damaged rice paddy and tankage.
Lot VI. Finely ground damaged rice paddy and tankage.

The hogs used in this trial were produced on the University Farm, were farrowed during September and October, 1922, and were representatives of the following breeds: Poland China, Duroc-Jersey, Berkshire, and Hampshire.

One of the striking facts noted was the difference in the rate of gain and in the amount of feed required to produce 100 pounds of gain in lots I and II. The average daily gains were 1.28 and 1.68 pounds, respectively, with 524.22 pounds for each 100 pounds gained by lot I and 440.34 pounds for each 100 pounds gained by lot II. Lot II, fed ground barley and tankage, made excellent gains on much less barley and tankage than was required in lot I. The total average gains were 114.3 pounds and 102.5 pounds, respectively. The pigs in lot VI made good gains and were well finished at the conclusion of the test. The amount of feed required to produce 100 pounds of gain in this lot was not excessive, being 504.10 pounds. The gains made by lot V were not large, though these pigs consumed an excessive amount of tankage, making the gains expensive.

The results of the test indicate that paddy rice and damaged paddy rice when finely ground can be successfully fed to fattening swine in the dry lot when supplemented with tankage.

Study of the Growth Cycle of Swine.—On March 9, 1923, a preliminary experiment was begun at the University Farm to determine the rate of growth of swine from birth to maturity.

The animals being used in this trial are pure-bred pigs from gilts and sows selected at random. Pigs from Poland China, Duroc-Jersey, Berkshire, Hampshire, and Tamworth sows and gilts are being used. A few days previous to farrowing, each porcine is driven to a farrowing house. For several consecutive days before and after farrowing, record is made of each sow's daily weight.

Each newly born pig is dried and weighed soon after birth and, if possible, before suckling. Each sow and her pigs are weighed individually at the same time of day for several days after farrowing. From this time on, individual weights of each sow and her pigs are taken at weekly intervals. Weekly weights

* Undamaged rice paddy not so coarsely ground as the damaged rice paddy fed in lot V.

of the sows will be taken until their pigs are weaned. Similar weighings of the pigs will be recorded until maturity or time of marketing. After weaning, accurate records of both feed consumed and weekly gains will be taken.

It is hoped that this trial is at least a beginning of more comprehensive trials in the future for the determination of the growth cycle of swine.

Tannery Waste Feed Experiment.—Between July 27 and October 28, 1922, there was conducted at the University Farm an experiment to determine the feeding value of tannery waste. Pure-bred Berkshire, Poland China, Duroc-Jersey, and Hampshire hogs from the University Farm herd were used in this test.

Fig. 42.—Pen of five Poland China barrows. Bred, fed and exhibited by the University of California. International Livestock Exposition, Chicago, 1922. First, second, and third in class. First and second in pen of three. Reserve Champion pen.

Six lots of five hogs each, averaging 69.2 pounds, were self fed the following rations in dry lot. Lot VI was self fed rolled barley and hand fed skim milk three times a day.

Lot I. Rolled barley, self-fed.

Lot II. Rolled barley and tankage (60 per cent protein) self-fed in separate self-feeders.

Lot III. Rolled barley and tankage (45 per cent protein) self fed in separate self-feeders.

Lot IV. Rolled barley 9 parts and tannery waste 1 part, mixed and fed in self feeder.

Lot V. Rolled barley 90 parts and tannery waste 11 parts, mixed and fed in self feeder.

Lot VI. Rolled barley, self-fed in self-feeder, skim milk fed in liberal amounts three times a day.

This trial covered a period of 94 days.

The average weight gained by each pig was found to be as follows:

Lot I.	57.7 lbs.	Lot V.	62.7 lbs.
Lot II.	101.8 lbs.	Lot VI.	125.9 lbs.
Lot IV.	44.2 lbs.		

Three of the five hogs in lot III died early in the experiment. These deaths were caused by an accumulation of sand and gravel in the hogs' stomachs and intestines. It is thought best not to report the results of lot III on account of the few hogs remaining in the lot.

The highest average daily gain, 1.34 pounds, was noted in lot VI which was fed, for each 100 pounds gained, 295.44 pounds of rolled barley and 1217.19 pounds of skim milk. The lowest, 0.47 pound, was noted in lot IV, which received 677.44 pounds of rolled barley and 75.27 pounds of tannery waste for each 100 pounds gained. Lots I and V experienced practically the same average daily gain 0.61 pound and 0.67 pound, respectively, requiring for Lot I, 571.92 pounds of rolled barley for each 100 pounds gained and for lot V, 527.91 pounds of rolled barley and 68.42 pounds of tannery waste for each 100 pounds gained.

The results of this test are in no way conclusive. Additional trials will be conducted in the future.

The Animal Husbandry Division in coöperation with the Department of Anatomy of the University of California entered upon an experiment to determine whether the hog stores fat soluble vitamine "A" in its body stores of fat. Two lots of three pure-bred Hampshire hogs, just weaned, averaging 60 pounds in weight at the beginning of the feeding trial, were used. Lot I was fed shelled yellow corn and alfalfa, and lot II, shelled white corn. Lot II made much better gains than lot I and finished much less uniformily. On January 20, the animals were transferred to the Division of Anatomy for slaughter and determination of vitamine content of body fat.

Horse Breeding.—The breeding stud consists of twenty pure-bred percherons and seven shires of all ages, two standard bred mares, two thoroughbreds, and two grades used for saddle purposes. The mature draft mares are worked on the Farm in addition to raising colts; the light mares have colts sired by the Government Remount stallion.

Mrs. Anita Baldwin has presented to the University Farm, in the form of perpetual loan, the Percheron stallion, Jusque, and the choice thoroughbred mares, Cruzada and Norette, the former with foal at foot.

Remount Service.—The Government stallion, "Gun Rock," was placed at the University of California at Davis by the Remount Division of the United States War Department with the object of developing stock horses, good riding horses suitable for the cavalry, and horses to fill the various classes for which riding animals are used.

"Gun Rock" was received at Davis in April, 1921. He served 30 mares during the season of 1921, 37 in 1922, and over 55 in 1923. The breeding service of the stallion is absolutely free to the horse breeders of the state the only charge being the cost of feed consumed by mares while at Davis during the breeding season.

The saving in the service fees alone means thousands of dollars to California horse breeders, besides giving them colts of inestimable value sired by this stallion. As the colts mature, they will mean a great source of income to their owners.

Schweizer Electrical and Italian Methods of Green Forage Preservation.—During the past year an additional test* was made of the Schweizer electrical and the Italian methods of preserving green forage. (For description of equipment and process used in the test on the Schweizer electrical method, see Agricultural Engineering Report, p. 50). The jars were filled on October 17, 1922, and charged with electricity. When opened on May 14, 1923, a large amount of spoiled silage was found on the top of each jar; otherwise the silage was in good condition and the honey sorghum was particularly bright in color. When fed to dairy cows, both lots of silage were found to be palatable and were readily consumed.

Jar 3, used in the test of the Italian method, was filled with 569 pounds of corn silage which had been allowed to wilt in the field for 30 hours. The jar was then sealed with an airtight lid. When opened on May 14, the jar was found to contain practically no spoiled silage. The silage was in good condition and quite palatable when fed to dairy cows.

The Italian method appears to be practical and economical, while the Schweizer electrical method is prohibitive in cost according to the results of investigations to date.

Milch Goats.—The Farm flock of Toggenburg milk goats originating from a gift of two does by Mr. Winthrop Howland of Redlands, in 1913, now numbers thirty-six pure-bred females. There are thirteen grade Toggenburg does, and recently Miss Beatrice A. B. Stocker, of Bloomfield, presented a pair of Anglo Nubians.

Milk is being used in experiments conducted by the Dairy Industry Division in the production of Roquefort cheese.

High School Judging Contests.—Live stock judging contests for high school pupils of the state, under the direction of members of the State Department of Education and of the Division of Agricultural Education in the College of Agriculture have been conducted under the supervision of members of the Division of Animal Husbandry at the State Fair at Sacramento, at the Southern California Fair at Riverside, and at the University Farm, Davis. At the first two regional contests 120 and 75 students, respectively, participated, while at the final contest at Davis a team was chosen to represent the high schools of the State at the Pacific International Live Stock Show at Portland.

Members of the Division acted as judges in contests at the Extension Division Club Convention, Davis, at the University Farm Picnic, at the Chaffey Union High School Junior Fair, at Riverside, and at the Sonoma-Marin County Fair. More than 500 boys and girls took part in these contests. High school instructors in agriculture have brought members of their classes to the Farm for week-end practice and coaching by members of the division. Two hundred and fifty men and boys have availed themselves of this opportunity during the year.

Judging at Fairs.—Members of the division have responded to thirty-nine calls to act as judges of livestock at fairs held in twenty-two different counties of the state, including Del Norte, Humboldt, Trinity and Lassen in the north, Inyo, San Diego, Riverside, Los Angeles, and Ventura in the south. Not only have these men performed the service of judges in the matter of placing animals in the show ring, but they have given discussions of placings and in some cases given public addresses on subjects related to their work at the fair.

* Report of the College of Agriculture and Agricultural Experiment Station, University of California, 1921–22, p. 59.

CITRUS EXPERIMENT STATION AND SUB-TROPICAL HORTICULTURE

Citrus Nursery Stock Tests.—The comparative tests of large, intermediate and small nursery trees of the same age, H. J. Webber reports, continue to show the superiority of the large trees after six years in the orchard.* The difference, however, does not appear to be so marked as in earlier years and some of the trees in the plot planted with small nursery trees are nearly as large as those in the plot of large nursery trees. Confirmatory evidence of the importance of discarding the small trees in a nursery when grown from unselected stocks has been found during the year in a grove of Valencias planted on the San Marino ranch near Pasadena. Here a nursery of unselected sour orange stocks was budded to Valencia. When the nursery treees were of proper age, a 20-acre grove was planted with the largest select trees of the nursery. Slightly later a second 20-acres was planted with the best trees remaining, after which a third portion of the orchard was planted with the remaining trees, which were undersized but apparently healthy. The orchard is now six years of age and clearly shows the superiority of that portion planted with the largest and best nursery trees. It seems evident that the largest and best growing trees in a citrus nursery give the best results and that slow, poor growing trees should be discarded.

Citrus Root-Stock Studies.—The investigations on citrus root-stocks has been continued by H. J. Webber† and preparation is being made to extend the comparative tests to include all promising stocks available. Seed bed stock is being grown of a number of different species and selected types to use in this experiment. Meanwhile orchard studies in different parts of the state are furnishing data of considerable value.

The data gathered strengthens the conclusion that not all types or varieties of a species make satisfactory stocks. The sour orange has been extensively used as a stock for the lemon, yet not all sour orange seedlings make good lemon stock. In many cases the lemon budded on sour orange seedlings give good smooth unions and even growth, while in other cases the scion overgrows the stock and is swollen at the union. In such cases the passage of nutrition from the leaves to the roots is evidently interrupted to some extent at the union so that the roots are not properly nourished. Observations in several orchards in different parts of the state indicate that the trees with such swollen bud unions are likely to be small in size and of poor character, while other trees in the same grove with smooth even bud unions are much larger and better trees. This indicates a variability in the congeniality of the different sour orange seedlings used. In other lemon orchards all of the bud unions may be smooth and even, and all the trees comparatively uniform in size. In such cases the sour orange seedlings used have probably all come from a uniformly good stock type of sour orange. The same conditions have been observed to some extent in the case of Navel on Sour orange, and of grapefruit on grape-

---

* Report of the College of Agriculture and Agricultural Experiment Station, University of California, 1921–22, pp. 67–68.

† Report of the College of Agriculture and Agricultural Experiment Station, University of California, 1920–21, p. 82; 1919–20, pp. 33–34.

Fig. 43.—Five-year-old Valencia orange grove on San Marino Ranch planted with select large nursery trees. Photo June, 1922. (Compare with fig. 2.)

Fig. 44.—Five-year-old Valencia orange grove on San Marino Ranch planted with intermediate sized nursery trees. Photo June, 1922. (Compare with fig. 1.)

fruit stock. The accumulating evidence all points strongly to the conclusion that whatever species we may use as a root stock, it is important that selected stock varieties be secured for seed production, which can be depended upon to give seedlings of good vigorous growth and full congeniality with the scions to be used.

Observations indicate that the Florida Rough lemon may prove to be a good stock for the lemon and also for the Washington Navel, particularly in the dry interior valleys.

Fig. 45.—Valencia orange on Trifoliate orange stock. A poor, dwarfed tree; shows the effect of uncongenial overgrown stock

The reactions caused by the use of the Trifoliate orange stock have been studied in a number of groves and are very difficult to understand. When Navels or Valencias are budded on Trifoliate orange, the almost universal reaction is to cause the stock to overgrow the scion (fig. 43). The trees, however, may grow well and give good results or they may be small, weak and sickly. It may be that here also we are working with good and poor stock strains.

Single or Combined Fruit Culture.—The general practice in the United States in the planting of fruit orchards of any kind is to plant one kind of fruit only in an orchard. In some instances different fruits have been mixed in the same orchard with good success, and in many tropical regions mixed culture is regularly pursued. H. J. Webber reports that for several years he has been making observations on the general subject of monoculture versus polyculture

and that the results obtained with various combined plantings in the state have been sufficiently promising to justify attention being directed to the subject as one worthy of careful study and experimentation.

Such plantings that have been studied in various parts of the state include mainly the following combinations: citrus and walnuts, citrus and apricots, citrus and prunes, citrus and pears, citrus and avocados, citrus and olives, citrus and grapes, citrus and dates, walnuts and apricots, and apricots and grapes.

The possibility of the successful combination culture of two perennial fruit crops rest apparently upon two fundamental considerations: (1) the mutual congeniality of the two crops concerned; (2) the possession of similar cultural requirements, namely, soil, water, and nutritional requirements.

As to combinations that are likely to be most successful in California, only a few suggestions can as yet be made. In the Imperial and Coachella valleys, where dates and grapefruit are being planted rather extensively and are expected to develop into important industries, conditions suggest that a combined planting might be more successful than monoculture. The studies indicate that the date, which ultimately grows to a high tree and gives only a light, partial shade, furnishes just the conditions of shade and wind protection best suited to the grapefruit and that the grapefruit trees do not seriously detract from the growth and development of the date.

In the hot and dry interior valleys of the state where the orange is so seriously affected by the so-called June Drop, some combination culture may prove valuable. Very suggestive results have been obtained by certain growers with such combinations as oranges and apricots, oranges and prunes, oranges and walnuts, and the like. Rather extensive observations made in various parts of the state indicate that these crops grow well together and are what may be termed mutually congenial. It is rather surprising to observe that a row of orange trees next to a row of walnuts of the same age and many times larger, is apparently in no way injured by the walnuts unless so close as to be too greatly shaded.

No recommendations can as yet be made regarding successful polyculture of fruits. Attention is directed to the subject merely as one of great interest for study and observation.

Reclamation of Black Alkali Soil.—The field experiments at Fresno have been enlarged by E. E. Thomas to include the use of sulphuric acid, calcium chlorid, calcium nitrate, iron sulphate, alum, manure and lime. The areas treated with these materials last summer were planted in barley. A satisfactory yield was obtained by the use of calcium nitrate, and promising results followed the use of calcium chlorid and iron sulphate. A complete failure of crop resulted where both lime and manure were used. The effect of alum was only partially successful. The indications are that iron sulphate, if applied in conjunction with nitrogenous fertilizer, may prove to be a valuable treatment for this soil.

The plots previously treated wtih gypsum and sulphur* were planted with a cover crop of melilotus indica. The result indicated that the sulfur treatment is now becoming very effective. A uniform stand and good growth of cover crop were obtained where sulfur has been used, whereas this soil before treatment contained so much black alkali as to prevent entirely germination.

* Report of the College of Agriculture and Agricultural Experiment Station, University of California, 1921-22, p. 50.

Laboratory Studies on the Effects of Salts on Soils.—A. B. Cummins has continued studies on the formation of sodium carbonate in soils. In addition to replacement of bases as a prolific source of black alkali, the reaction of neutral salts with calcium carbonate may also, under suitable conditions, give substantial amounts of sodium carbonate. Special studies have been devoted to the equilibrium between neutral sodium salts and calcium carbonate and additional studies on the reaction between neutral salts and various pure silicates.

Use of Saline Irrigation Water.—S. M. Brown finds that the soluble salts applied in irrigation water do not necessarily accumulate in the upper soil zone but, instead, may move downward to great depth. The soil of citrus groves previously irrigated for twelve years with water high in chlorid, have been found to contain practically uniform amounts of chlorid to a depth of more than twenty feet. Similar studies show that nitrate when applied as a fertilizer at Rubidoux penetrated to a corresponding depth.

Fertilizer Plots at Rubidoux, Soil Studies.—S. M. Brown finds only slight differences in the amounts of the water soluble constituents in soil samples taken periodically from certain of the fertilizer plots on which the condition of the citrus trees is radically different. On the other hand, by the use of the displacement method of study, he finds that the rate of renewal of the soil solution is directly related to the treatments previously applied to the soil and the results obtained by this method may be correlated with the present condition of the trees.

Cull Walnuts.—For the past three years L. D. Batchelor and J. T. Barrett have been studying the causes which produce abnormally high percentages of black meated and moldy cull walnuts.* The investigation was practically concluded during the 1922 walnut harvest, and several helpful and practicable recommendations have come from this work. The conclusions may be summarized as follows:

The work has shown conclusively that nuts will mold readily on the trees at any time after the husks start to crack, the mold starting its growth on the damp lining of the husk and finally spreading to the kernel. The vast majority of the nuts which are going to be moldy are in this condition before they reach the curing yards. The mold makes nearly all its growth while the kernels are still very moist. The first drying out at the beginning of the curing process checks any further development. The percentage of moldy nuts increases rapidly if the harvesting operations are delayed, especially if the nuts are still in the husks, even though they are partly cracked open and still on the trees. Many thousands of dollars can be saved by the walnut growers of the state if the crop is so grown and harvested that the percentage of moldy nuts is reduced to the practical minimum. The following recommendations are strongly urged:

1. Use enough late summer irrigation water so that the trees hold their leaves through the harvest season, and the nuts drop free from the husks.

2. Hasten the harvest in general; shake the trees at the first picking, and have crew enough to go over the entire orchard once a week shaking the trees each time.

3. Any trees that show a tendency to produce green sticktights, should be stripped of the crop the first time over, and husked by hand, if necessary. Such nuts will have to be husked some time; if they are taken in time they will

* Report of the College of Agriculture and Agricultural Experiment Station, University of California, 1920–21, p. 79.

be first grade nuts, but if they are neglected, and the husks become musky, they will be culls.

4. Knock off all the black stick tights at the first picking, and husk them promptly.

5. Keep all the dry stick-tights, musty stick-tights, and sunburned nuts separate from the rest of the crop in the grove and curing yards, and deliver them to the packing house separately.

Citrus Culture in Tulare County.—R. S. Vaile and G. J. Surr report progress in the Tulare County Orchard Management* as follows:

1. After a three years' trial in the citrus orchard field studies in Tulare County it is apparent that alfalfa is not a satisfactory crop to grow permanently in mature citrus groves, even when planted only on alternate middles. It may, however, serve a useful purpose when grown only for two or three years in breaking up impervious or compact layers of soil below the plowed area.

2. Purple Vetch proved to be an excellent winter cover crop on the heavy adobe soils of Tulare County during the winter of 1922–23. This crop has not previously been given a thorough trial in that region.

3. The adobe soils retain their moisture at a high point during the early spring, even when the rainfall is light. Measurements of moisture content of each soil in the experiment grove at Lemon Cove indicate that in years of heavy spring rainfalls, unless a winter cover crop is grown, the adobe soils are too wet for bacterial action and for satisfactory spring growth until late in the blossoming period. It is also apparent from these trials that winter plowing may be an aid in obtaining satisfactory soil moisture and temperature conditions during the early spring.

Survey of Citrus Orchard Practices.—A summary of the citrus orchard survey made during the year by R. S. Vaile brings out the following points:

1. Orange groves when given reasonable care may be expected to increase in yield until they are at least 35 years of age; 20-year-old trees may be expected to produce about 85 per cent as much fruit as 35-year-old trees, and 10-year-old groves about 50 per cent.

2. Highest yields from mature citrus groves are obtained when from 250 to 400 pounds of actual nitrogen are applied to each orchard acre, about half of which is derived from bulky organic manure. When larger quantities are applied, the yield is generally lessened and the trees are often severely mottled. When smaller quantities of nitrogen are used, the yield is correspondingly decreased. Groves that have received only 50 to 100 pounds of actual nitrogen to the acre have produced about 50 per cent as much fruit as those receiving 250 to 400 pounds. The increases in yield with increased application of nitrogen follow a typical curve for diminishing returns. The limit of nitrogen applied for profitable cultivation varies for individual cases, but ordinarily it will be between 200 and 300 pounds to the acre. On this basis, 70 per cent of the citrus growers are under-feeding their orchards and possibly 5 per cent are over-feeding.

Internal Decline of Lemons.—The following additional conclusions† may be drawn from the continued work of E. T. Bartholomew on internal decline: (1)

* Report of the College of Agriculture and Agricultural Experiment Station, University of California, 1921–22, pp. 69–70.

† Report of the College of Agriculture and Agricultural Experiment Station, University of California, 1921–22, p. 72.

Field observations, checked by laboratory experiments, have shown that lemon trees and fruits weakened by the freezes of 1921-22 produced more interna decline than those not thus injured. (2) The determination of the comparativ numbers of seeds in sound vs. decline lemons showed that the number of see in a lemon fruit does not affect its susceptibility to internal decline. (3) I decline yellow lemons there is usually not more than one-fourth to one-ha as much juice and citric acid as there is in normal lemons of the same colo The contrast is less marked between normal and decline silver lemons. Betwee normal and decline green lemons there is very little appreciable difference.

Alternaria Rot in Lemons.—The following additional conclusions may b drawn from the results obtained by E. T. Bartholomew in the continuatio of his investigations on Alternaria rot in lemons.*

1. Lemons infected with Alternaria have been found in all lemon growin districts of southern California. The disease is more prevalent in some grove and packing houses than in others.

2. Before the investigation began it was supposed that after the fruit ha been picked and stored or while it was in transit it became weakened to suc an extent that spores adhering to the surfaces of the lemons or buttons ger minated and thus produced infection which resulted in the decay of the fruit The following data show that this is not the case: (*a*) Thorough sterilizatio of the surfaces of the lemons and buttons does not prevent decay; (*b*) Button removed from the lemons and sterilized to kill all surface spores will show 7 to 100 per cent infection with Alternaria; (*c*) If the lemons from which the buttons were removed are surface sterilized and stored, they will show from 50 to 100 per cent infection with Alternaria.

3. Investigation has shown that the initial infection of the button take place very early, probably at the time of the withering of the petals and the tips of the calyx. From this time on the fungus progresses very slowly bu sufficiently rapid in many cases to have entered the lemon tissue under the button by the time the lemon is picked. Any condition or set of conditions which will weaken the tissues of the button or lemon will permit of an accelerated rate of growth of the fungus.

4. Further investigation has shown that not only the lemon buttons but als the young stems below the buttons (pedicels) become infected at an early stage Initial infection of the stem takes place through the withering tips of the small scale-like bracts on its surface. It seems at least possible that the presence of the Alternaria in the stems may be one of the factors causing the excessive dropping of the young fruits.

5. The results so far show that Alternaria rot in lemons cannot be con trolled by the use of sterilizing solutions in the packing houses. It is hoped that some measure of success in controlling the loss caused by this fungus may be had through the use of proper sprays in the groves. Tests to determine this possibility are being made at the present time.

Comparative Resistance of Prunus Stocks to Crown Gall.—The study of the resistance of Prunus to Crown Gall has been continued by C. O. Smith.† Many tests were made by artificial inoculations during the growing season on the ear

* *Ibid.* P. 73.

† Report of the College of Agriculture and Agricultural Experiment Station, University of California, 1921-22, p. 74.

rent year's growth. Each week from May 1 to September 1, ten inoculations were made on each stock as an experimental test. Some of the more promising species of Prunus and Amygdalus from a stock standpoint are here listed in the order of their resistance; sand cherry (*P. pumila*), sloe (*P. umbelata*), Italian prune (*P. domestica*), Japanese apricot (*P. Mume*), dwarf almond (*A. tangutica*), sand cherry (*P. Besseyi*), Chickasaw (*P. Angustifolia*), Texas big plum (*P. mexicana*), Indian cling (*P. Persica*), Myrobolan (*P. cerasifera*).

Fig. 46.—Crown Gall as it develops on different hosts. Nos. 1 and 2 represent galls produced artificially on the resistant Japanese apricots (*P. Mume*). The variety in No. 2 is considerably more susceptible than that in No. 1, and the galls are somewhat larger. On this host they are generally small, point like, and for the most part do not further increase in size from July to December. No. 3 shows artificial galls on Italian prune (*P. domestica*) which is strongly resistant from July to December. No. 4, Myrobolan plum (*P. cerasifera*), inoculated July 13 and photographed September 15, shows large rapidly growing gall on a susceptible host.

The *Prunus Mume*, the Japanese apricot, has been the most thoroughly tested, having received [illegible] inoculations. In general, it is strongly resistant to Crown Gall, showing a 6.4 per cent resistance to galls. Considerable difference was found, however, in the different seedlings tested. The seedling having the S. P. I. number [illegible] (1300 inoculations) gave 13.5 per cent infection, while the seedlings S. P. I. [illegible] (1290 inoculations) showed 4 per cent infection.

None of the tree species of Prunus or Amygdalus thus far tested, has shown a complete resistance to artificial inoculations. The evergreen species such as *P. integrifolia*, *P. ilicifolia* and *P. caroliniana* have shown a complete resistance to all artificial inoculations.

Field Tests of Prunus Stocks Resistant to Crown Gall.—Progress has been made by C. O. Smith in testing as stock species of Prunus resistant to Crown Gall.*

P. Mume (Japanese apricot) has been grown in the Station Nursery at Riverside. Budded trees of several of the popular varieties of peach, plum, apricot and almonds are now growing on this root in an orchard planting. It is probably too early to give final recommendation of its value as a stock. Apricots (Royal, Hemskirk, Moorpark, Tilton) have done well on the *Mume* root, comparing very favorably with the growth on peach or apricot root. It also seems to be a good root for *P. domestica* (Sugar Prune, Tragedy, Grand Duke, French Prune). The Japanese plums make a fine growth on *P. Mume* but some of them develop a poor union, and further time is necessary to test its value for this class of plums. Peaches and almonds have not done well on *Mume*, and further time is needed to determine fully its value for species of *Amygdalus.*

All of the stone fruits take well on *P. Angustifolia* (Chickasaw Plum), and make a satisfactory growth. This stock may have a limited use for wet situations. Its chief disadvantage lies in the fact that it suckers too freely.

P. Besseyi (Sand Cherry) is also being tested as a dwarf stock. It buds easily to all the stone fruits as well as almonds. The buds make a most remarkable growth in the nursery, and the growth in the field (two years' time) has been most satisfactory. The trees are fully as large as those on any of the popular stocks in use. It will be interesting to see if this growth continues. At present *P. Besseyi* seems to be a very precocious stock.

Resistance of Young Walnuts to Walnut Blight.—Further tests of the resistance to Walnut Blight of the young nut of the chief commercial varieties of English walnut have been made by C. O. Smith† by actually inoculating the small nuts at frequent intervals during April, May, and June. The results agree closely with those previously obtained, and can be summarized as follows:

Variety—	Number of Inoculations	Number Blighted	Per-cent Blighted
Franquette	106	61	57
Ehrhardt	655	397	60
Placentia	359	233	65
Mayette	251	181	71
Eureka	354	268	76

The difference in amount of blight between the different varieties is not sufficient to be significant. The experiment shows no marked resistance to actual inoculations with cultures of the walnut blight organism. The infections that developed were, for the most part, lateral rather than blossom end blight, a result which is in marked distinction to what usually takes place in nature. Can the inoculum causing the stigma infection be carried by some agent other than water, such as pollen for example?

Spraying versus Dusting for the Codling Moth in Walnuts.—Four walnut orchards in the Carpinteria section and two near Tustin were treated under the supervision of H. J. Quayle by spraying and dusting for the Codling moth.‡

* *Ibid.* P. 74.

† Report of the College of Agriculture and Agricultural Experiment Station, University of California, 1921–22, p. 73.

‡ Report of the College of Agriculture and Agricultural Experiment Station, University of California, 1921–22, p. 75.

The results confirmed and emphasized the findings of previous years that spraying is more efficient than dusting and may be even less expensive.

A count of nuts from the various plots gave an average of wormy nuts as follows: Sprayed plots, 8.3 per cent wormy; dusted plots, 16.91 per cent wormy; check plots, untreated, 21.78 per cent wormy. Average cost per tree: spray, 41.23 cents; dust, 55.45 cents.

Fig. 47.—Horizontal lemon branch showing the effect of bending in the opposite direction after laterals had begun to grow on the dorsal side.

Fumigation with Calcium Cyanide Dust.—A new system of fumigation for the control of scale pests on citrus trees has been developed by H. J. Quayle and H. Knight, assisted by F. C. Greer. This consists in discharging under a tented citrus tree, by means of a suitable dusting machine, a given quantity of finely pulverized calcium cyanid $Ca(CN)_2$. The dust fills the entire tented area, each minute particle giving off hydrocyanic acid gas. Unlike present fumigation methods with liquid HCN in which the gas becomes increasingly

diluted with air as it diffuses through the tent and thus does not reach the insect at its highest concentration, calcium cyanid dust generates HCN gas at the point of contact with the scale. The gas is generated gradually and uniformly in all parts of the tent at once, reaching its highest concentration in about 40 minutes, although after the first five minutes the concentration increases only slightly. A killing concentration is thus maintained throughout the entire exposure. Trees infested with black, citricola, and red scale when fumigated by this method in dry weather, were entirely freed of scale and showed no injurious effect.

Moisture seems to be a limiting factor, however, in the possible use of calcium cyanid dust as a tree fumigant. Burning and heavy leaf drop have occurred when rain followed the fumigation. The injury, however, appeared to be only temporary. Tests are being undertaken to determine whether this tendency to injury can be overcome; if not, then the use of this dust will be limited to sections where dry atmospheric conditions prevail.

Grape Leaf Hopper Control with Calcium Cyanid Dust.—Grape vines at Oasis, Coachella Valley, were dusted by H. Knight and F. C. Greer with pulverized calcium cyanid and hydrated lime with proportions of 10, 25, 50, and 100 per cent cyanid. Dust when used in strength above 10 per cent destroyed all nymphs and a large proportion of adults. No injurious effects to the vines have been observed. Operations were confined to the Coachella Valley on account of favorable climatic conditions for the use of the dust.

Soil Fumigation with Calcium Cyanid.—Tests with calcium cyanid in flake and dust form made by H. J. Quayle and H. Knight assisted by F. C. Greer, indicate that this material is well adapted to soil fumigation.

Wooly aphis and other soil infesting insects have been killed by the use of 2 ounces to the square yard. Better results were obtained in dry than in moist soil.

In October, 1922, soil around the base of apricot trees was treated with dust, using from 2 to 5 ounces to a tree. No signs of injury have been observed. The trees appear vigorous and have set a good crop of fruit.

Satisfactory results against the peach tree borer have been obtained with 2 ounces of dust to the tree, applied directly to the trunk and well covered with dirt. No injurious effects to the trees have yet been observed.

*Red Spider on Citrus.**—Comparative spraying tests in San Diego County by H. J. Quayle and H. Knight in coöperation with the farm advisor indicate that lime sulfur and sulfur sprays in this section do not give as good results in controlling red spider as do some of the miscible oils. This is due no doubt to peculiar local climatic conditions, the temperature seldom being high enough to render sulfur sprays effective.

Effect of Temperature on Resistance of Insects to Fumigation.—In order to ascertain by comparative tests whether or not actual resistance to HCN gas was induced while coccinellid beetles were inactive or dormant, they were subjected to temperatures ranging from 24° to 36° F. from 12 to 24 hours and fumigated, with checks kept at atmospheric temperature. Approximately 56.70 per cent of the cold beetles and 93.46 per cent of the warm beetles were killed.

In order to determine whether scale insects were affected in the same manner H. Knight and F. C. Greer subjected lemons infested with red scale, and

* Report of the College of Agriculture and Agricultural Experiment Station, University of California, 1921–22, p. 75.

potted oleander cuttings infested with black scale, beetles being present in both cases, to uniform temperatures of 30° and 40° F. for 72 hours. Lots were taken from each at intervals of 12, 24, 48 and 72 hours. At the expiration of 12 hours the results were as follows:

17.4 per cent of the beetles killed at 30° F. and 15.7 per cent at 40° F.; 85.48 per cent of the red scale killed at 30° F. and 98.55 per cent at 40° F.; 84.32 per cent of the black scale killed at 30° F. and 100 per cent at 40° F.

The check not fumigated showed that at the end of 12 hours, 54.70 per cent of the red scale and 50 per cent of the black scale were killed at 30° F. After 24 hours, 11.4 per cent of the beetles were killed at 30° F., and 28.1 per cent at 40° F., 88.32 per cent of the red scale at 30° F., and 99.39 per cent at 40° F., 95.56 per cent of the black scale at 30° F., and 100 per cent at 40° F. The check not fumigated showed that 82.1 per cent of the red scale and 93.13 per cent of the black scale were killed at 30° F.

Fig. 48.—Horizontal Eureka lemon branch showing the distribution of laterals on the upper, and dormant buds on the lower, side.

Studies on Growth and Differentiation in the Lemon Tree.—F. F. Halma has investigated the influence of the position of branches on the production of lateral shoots. He found that long succulent Eureka lemon branches bent in a horizontal position produced over twice as many laterals as branches which remained vertical. Nearly all of the laterals produced on the horizontal branches were of the fruiting type while about half of the laterals produced by the vertical branches were long and succulent. On horizontal branches twigs are produced only along the upper side, while on vertical branches they are confined to the apical region. The number of laterals on a horizontal branch can be increased by bending the branch in the opposite direction after a set of laterals has been produced on the upper side. A new set of laterals is then produced from dormant buds previously located on this lower side. In this manner the number of laterals was increased one and one-half times. The behavior of horizontal branches is considered further evidence in favor of the

* Report of the College of Agriculture and Agricultural Experiment Station, University of California, 1921-22, p. 75.

existence of an inhibiting substance. The fact that buds on the lower side of horizontal lemon branches remain dormant suggests that this hypothetical substance directed by gravity settles in the lower side of the branch and prevents lateral growth in that region. When the position of the branch is changed after laterals have appeared on the upper side, the new set of laterals inhibits further elongation in the original set.

Growth and Correlation in Apricot Branches.—In an attempt to study the problems of growth and differentiation, H. S. Reed has investigated the branches of the apricot tree and reports that the main axis of the apricot branches shows distinct cyclic growth during the first season. Each cycle of growth may be expressed by a logarithmic equation similar to that of autocatalysis.* The maximum rate of growth occurred in the fifth and sixth weeks. The branches were less variable with respect to their length than to any other character studied. Their frequency polygon is fairly symmetrical with respect to its mean and does not depart widely from the type of polygon which represents a chance distribution of characters in biological material. The mean length of all laterals was more than seven times that of the branches on which they were borne. There was not a high degree of association between the number of laterals to the branch and the length of the branch, but there was a high degree of association between the length of branch and length of laterals it bore. The location of the branches and their angle with the perpendicular had certain effects upon their growth and differentiation. Branches on the north side of the tree produced the maximum number of primary laterals and blossoms. Branches which made an angle of 60–90 degrees from the perpendicular had fewer laterals and blossoms than those which were more nearly upright.

The distribution of laterals and blossoms showed wide divergence from the normal frequency distribution of variables. Groups containing the smaller numbers of laterals and blossoms to the branch had by far the greatest frequencies. The types of distribution suggest that the numbers of these entities are dependent, not upon the chance factors of the environment, but upon hereditary factors. Most of the nodes remained dormant through the first season. The ratio of nodes which produced laterals indicates a cyclic distribution of the forces which break the dormancy of lateral buds.

The configuration of primary laterals on the branch afforded suitable material for the study of the statics of cyclic growth and gave satisfactory evidence of a definite distribution of matter in space. The production of material for the formation of laterals appears to follow the same mathematical relations as the growth of the branch. A method is described by which it is possible to compute the length of a lateral situated at a given node.

The production of secondary laterals and the length which they attain does not appear to be conditioned upon the factors located in the environment to any great extent. The mean number of secondary laterals to the branch indicated a close correlation with the mean number of primary laterals. The correlation between the mean number of secondary laterals to their mean length indicated that the size of the lateral is not dependent upon the factors which determine their numbers. The mean lengths of primary and secondary laterals on a branch showed a good positive correlation, indicating that the factors which operate to determine the length of one order of laterals act similarly on the other class.

---

* Report of the College of Agriculture and Agricultural Experiment Station, University of California, 1921–22, p. 72.

Fig. 49.—Vertical Eureka lemon branch showing the distribution of laterals near the apex and the dormant sub-apical buds.

The main axis of the branch produced very few blossoms; the primary laterals bore the majority of those produced in the first season. The mean number of blossoms to the lateral tends to be rather constant regardless of the length of the laterals, and indicates that factors of the environment are less important than hereditary factors in determining distribution. The blossom-node surface gave good evidence of two classes of laterals on apricot branches; the larger class showed a tendency toward a linear regression of blossoms on nodes; the smaller class was characterized by the possession of many nodes and few blossoms, and showed no definite tendency toward a linear regression.

The Effects of Sodium Salts on the Growth and Composition of Orange Trees.—H. S. Reed and A. R. C. Haas have continued their studies on the problems of absorption and growth under experimental conditions.* The trunk and roots are generally richer in sodium than other parts of the tree. A great increase in the sodium content of the nutrient solution is reflected in the composition of the tree as a whole, but the increase in the sodium content of the tree is by no means proportional to the increase of that element in the nutrient solution, in fact, the leaves, shoots, and trunk are not significantly richer in sodium than the corresponding parts of trees receiving less than ten parts to the million of sodium. When potassium was omitted from the culture solution, the trees absorbed slightly larger amounts of sodium, but gave no evidence that the increased amount of sodium performed any of the functions of potassium. The addition of appreciable amounts of sodium salts to a culture solution retarded the growth of the trees, especially manifesting its influence on the growth of shoots and rootlets.

Studies on the Effect of Calcium on the Growth and Composition of Orange Trees.—H. S. Reed and A. R. C. Haas have found that the ash of orange trees is relatively rich in calcium. The amounts found in leaves depend somewhat upon their age, the trunk and roots of the tree usually having higher percentages than shoots or rootlets. The ash of leaves from trees grown in soil is generally richer in calcium than those grown in a complete nutrient solution. The percentage of calcium bears some kind of inverse relation to that of potassium. The calcium of the trunk and root was relatively immobile in trees to which no calcium was supplied. The calcium is most soluble in the dry matter of leaves and rootlets, and least soluble in that of trunk and roots in trees from sand cultures. Trees which are afforded a supply of calcium salts show less injury from high concentrations of sodium salts. The lack of calcium usually results in characteristic injuries to the foliage, shoots, and rootlets (Figs. 50, 51, 52). The lack of calcium results in severe losses of leaves from the trees. Before their abscission the young leaves are covered with small dead spots. In certain cases the leaves were covered with raised, brown spots which were formed by proliferation of cells in the palisade layers of the leaf resulting in a papilla. These spots were subsequently impregnated with a black resinous material. Incipient mottling was observed where trees received inadequate supplies of calcium. The new leaves which followed the abscission of an earlier lot were frequently chlorotic. The repeated stoppage and starting of new growth led to the condition known as ''multiple buds.'' Shoots and rootlets eventually died, the latter becoming gelatinous. The effect of a calcium salt on the growth of citrus seedlings in water cultures was dis-

* Report of the College of Agriculture and Agricultural Experiment Station, University of California, 1921–22, p. 71.

tinctly beneficial. In the concentrations employed, the growth of roots was influenced more by the amount of calcium in solution than by the character of the anion with which the calcium cation was combined in the salt used. Citrus seedlings grown in a calcium chlorid solution will absorb more calcium cations than chlorid anions.

Fig. 50.—Young orange trees showing dead and defoliated shoots. Trees were grown in cultures which lacked calcium salts.

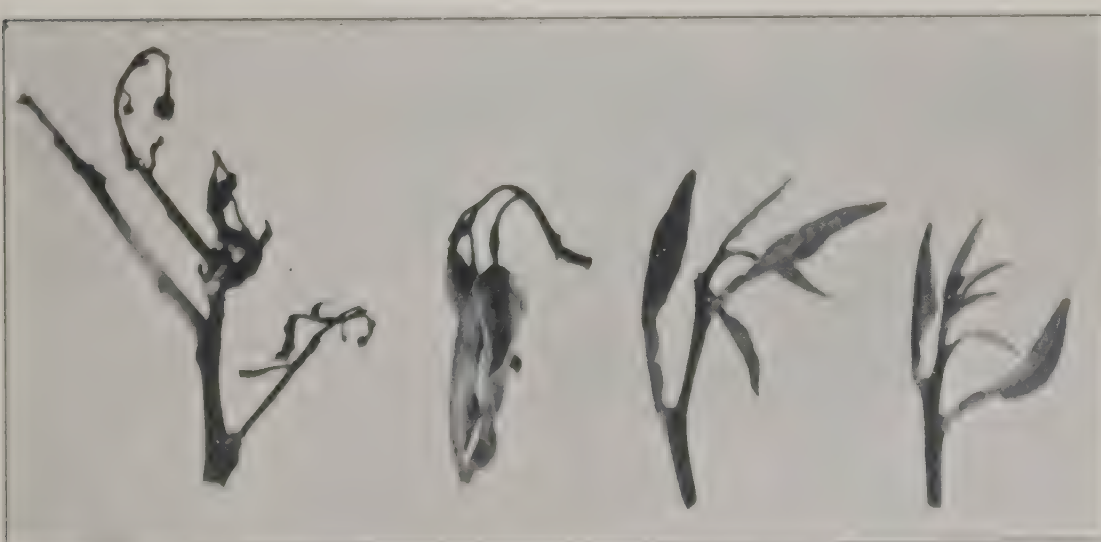


Fig. 51.—Shoot tips from orange trees which were grown in experimental cultures. The tips show the type of injury which occurs when calcium salts are withheld.

The Toxic Effect of Chlorides on Orange Trees.—H. S. Reed and A. R. C. Haas found that the application of large amounts of chlorides caused "tipburn," abscission of the leaves, and death of young shoots. The effects of sodium chlorid were specially evident in the restriction of root growth under conditions where osmotic influences were eliminated and caused death of old leaves if the concentration was much in excess of one thousand parts to the million. Calcium chlorid in concentrations up to three thousand parts to the million, in addition to the nutrient, increased the growth of roots and tops, although slight injury was caused by the higher concentration. The composition of the ash of trees reflects increased concentrations of chlorides in sand or soil cultures, and the entire amount found in the dry matter was water-soluble. Chlorid contents as high as 20 per cent of the ash were found in leaves severely injured by sodium chlorid. The trees absorbed chlorides in amounts greater than the molecular equivalent of sodium. Soils which had been irrigated with sodium chlorid solution until the trees were severely injured were freed from harmful amounts of chlorides by leaching with water and subsequent additions of nutrient solution. Although the leaching was not sufficient to remove all the chlorides, yet the trees made very satisfactory growth. Saline soil from an orange grove was greatly improved for trees by a similar process of leaching and treatment with nutrient solution.

Studies on the Relations of Potassium to Orange Trees.—H. S. Reed and A. R. C. Haas have found that orange trees in sand cultures to which no potassium salts were added made a fair growth for about a year and a half. There was a tendency for chlorophyll to fade in the leaves but no premature abscission occurred. The sap of the leaves was slightly more acid than that from trees in other cultures which received potassium salts. Leaves of trees to which no calcium salts were supplied were very rich in potassium, and, conversely, those receiving no potassium salts were significantly high in calcium. Where potassium salts were withheld, the roots and rootlets were the last to be depleted of that particular ion. Leaves from trees receiving no potassium were characterized by bronze-colored stripes on either side of the midrib. In advanced stages of injury, dead spots occurred in the bronze-colored areas. Prior to abscission there may be a general destruction of chlorophyll. Young leaves were frequently chlorotic for a time.

The Problem of an Iron Supply in Nutrient Media.—H. S. Reed and A. R. C. Haas have studied factors which affect the solubility of iron in nutrient solutions. The iron of ferric tartrate soon becomes converted into insoluble compounds when added to nutrient solutions. The conversion is more rapid in solutions of higher pH. The introduction of carbon-dioxide lowers the pH of slightly acid, neutral, or alkaline solutions, but does not increase the solubility of iron compounds which they contain. The addition of certain organic compounds to an alkaline nutrient solution increased the amount of soluble iron in the solution. This fact may be of significance in maintaining an adequate supply of soluble iron in solutions for the growth of plants.

The Effect of Hydroxyl Ion Concentration on Walnut Roots.—Repeated observations have shown that Persian Walnut trees are quite sensitive to alkaline conditions. H. S. Reed and A. R. C. Haas have found that much of the injury may be due to the effect of the hydroxyl ions on the nutrient media rather than to any direct effect on the plant. Under alkaline conditions calcium, magnesium, and iron may be precipitated to such an extent that the plants suffer from a

scanty supply of these ions. Walnut seedlings are very sensitive to the lack of calcium and show injury in a few hours in calcium-free solutions. They have been grown successfully for several weeks in renewed solutions of calcium hydrate which had a pH of 9.0 or higher. The injury to walnut roots from solutions of high hydroxyl ion concentration is to be ascribed principally to calcium starvation rather than to the effect of high hydroxyl ion concentration upon the plant.

Seasonal Variations in the Moisture Content of the Soil in a Walnut Grove.—L. D. Batchelor and H. S. Reed have continued previous work on the seasonal changes in soil moisture and on various factors which will affect soil moisture.* Observations have been made for a number of years on a bearing walnut grove located on fine sandy loam soil. Studies have shown that at the end of the

Fig. 52.—Orange leaves from trees grown in experimental cultures to which no calcium was furnished. The small pale leaves are marked with many small dead spots. Such leaves fall easily before reaching maturity.

growing season, the moisture was reduced to a point near the hygroscopic coefficient, in spite of summer irrigations totaling 12.5 acre inches for the season. When grown without irrigation, the walnut trees at the beginning of the dormant period had reduced the moisture in the upper five feet of this soil to 0.54 to 0.85 of the hygroscopic coefficient. In spite of the low moisture content of the soil in the latter part of the growing season, the trees showed no permanent wilting but continued to mature and entered the dormant period uninjured. Temoprary wilting occurred only during the middle of the day when a high temperature was accompanied by a low humidity. The moisture content of the soil was generally at the hygroscopic point at the end of the growing season, regardless of the amount of water present at the beginning of the growing season. The moisture content of the upper seven feet of the soil in this orchard gradually increased with the winter rainfall and usually reached a maximum percentage in March when the moisture present equalled from 2.5 to 3.5 times the hygroscopic coefficient. Early in April the amount

* Report of the College of Agriculture and Agricultural Experiment Station, University of California, 1920-21, pp. 79, 80.

of soil moisture was reduced, as the trees started their spring growth. The soil moisture of the upper four feet was approximately at the wilting point by the middle of June. The residual moisture in the subsoil area (5–7 feet) persisted until past the middle of the growing season. Irrigations in the summer time of 4.2 acre inches to the acre raised the water content for a brief time, but within 30 days it dropped back to the approximate value of the wilting point. Such irrigation had little effect on the water content of the soil below the fourth foot. By the end of October the soil in the upper seven feet was approximately at the hygroscopic point.

Fig. 53.—Typical leaves (one from each tree) from hybrid Citrus trees and trees representing the two parent varieties. A, Imperial grapefruit (non-hybrid seedling, doubtless from an adventitious embryo); B, Willow Leaf mandarin (non-hybrid seedling in another cross); C, thick-leaved variant type of grapefruit (non-hybrid seedling); rest, hybrids; all except B, from the cross Imperial × Willow Leaf.

Citrus Breeding.—The planting of the citrus breeding orchards at Riverside, including 5000 seedlings and more than 5000 trees budded from these seedlings, was practically completed by H. B. Frost in 1923. Several hybrid trees produced a few fruits in the season of 1922–23. A mandarin having King and Willow Leaf as parents produces fair-sized fruits of excellent quality, ripening before February 1. The remarkable variability characteristic of F_1 species hybrids of citrus is illustrated by the leaves shown in figure 53. A notable feature of the pedigree cultures is the occasional occurrence, among progeny both from selfing and from crossing, of weak or dwarf types; some of these forms have been budded repeatedly, and on stocks of two or three species, without securing anywhere an approach to normal vigor. Albino and partially albinistic plants are remarkably frequent in some lots of seedlings; evidently they are common among the plants from adventitious embryos (nucellar buds), and sometimes both white and green plants come from the same individual seed.

Fig. 54.—Matthiola plants. Three rows at left, progeny of a normal parent; all normal. Three rows at right, progeny of a slender sib of the first parent; seventeen slender plants (four classed as "extreme"), nine normal, and one (No. 2) smooth-leaved.

Heredity in Matthiola (stocks).—H. B. Frost's cultures involving the mutant types large-leaved (L), slender (S) and crenate (C), and the ancestral normal type (n), have given the following results in the F_1 generation from crossing: normal X mutant and mutant X normal give both normal and mutant progeny, the former cross usually giving proportionately more normals; S X L gives n, L, S, and LS; and L X S gives n, L, S, and evidently LS. When selfed these mutant types give both normal and mutant progeny (figure 54), none having bred true. Plants of the C and S types more often have single than double flowers, although the variety concerned normally gives about 53 per cent of doubles. Since all functional pollen in a "double-throwing" variety carries doubleness, a mutant gene linked with the single and double genes must be, when carried by the pollen, in a double-carrying chromosome; one would expect, therefore, no association between mutant type and singleness or doubleness in F_1 from the cross n♀ X S♂, and a reversal of coupling (slender and double associated) in F_2 from selfing of slender F_1. It has been found in several cultures, however, that the original association of characters still persists both in F_1 and F_2. No simple hypothesis, either of a linked mutant gene or of reduplication of a chromosome, seems adequate for this case.

Cytology of Mutants in Matthiola (stocks).—Study of the chromosomes in mutant types has been begun. H. B. Frost of the Citrus Experiment Station, and Miss M. C. Mann of the Division of Genetics, have found that the large-leaved type has one unpaired chromosome in addition to the seven pairs which are found in the pollen mother cells of the normal plants.

Hybrid Vigor in Raphanus (radishes).—The F_2 hybrids of *Raphanus* studied by H. B. Frost* have been much more variable than the corresponding F_1 lots in various characters. In size and vigor the F_2 hybrids have been inferior to F_1 but superior to the corresponding selfed lines. Red root color and thickened edible roots evidently depend on recessive genes (or imperfectly recessive in the latter case) which are biologically inferior to their normal allelomorphs and are maintained against natural selection only by human agency. Two parents have given 25 per cent of non-viable albino progeny when selfed, and other recessive or apparently recessive "abnormal" or biologically unfavorable characters have appeared in pedigree cultures. *Raphanus* therefore seems to give, like maize, some evidence in support of the hypothesis that heterosis (hybrid vigor) depends essentially on dominance of "favorable" genes.

The Moki Lima Bean.—In 1922, as in 1919, in small trials by H. B. Frost, white Moki Lima showed its ability to set a crop with irrigation at Riverside. It is a vining type, considerably later but somewhat larger-seeded than the Henderson Bush Lima, about equal to the Henderson in resistance to heat and drought, and of excellent quality. It seems promising at least for use as a garden vegetable in the hot interior sections of California.

White-seeded Cowpeas.—In small trials by H. B. Frost in 1919 and 1922, several so-called "white-seeded" cowpeas from the U. S. Department of Agriculture have been fairly early and productive when grown with irrigation at Riverside. Superior in flavor and appearance to the California Blackeye, such types seem to deserve attention as summer garden vegetables for interior sections.

---

* Report of the College of Agriculture and Agricultural Experiment Station, University of California, 1920–21, p. 93.

DAIRY INDUSTRY

Relation Between Acidity and Butterfat in Milk and Cream.— To establish a relation between the acidity and the butterfat in milk and cream, C. L. Roadhouse separated cream with butterfat percentages varying from 6.4 to 56 per cent and made acidity determinations for the skim milk, the original whole milk, and the cream. Six separate experiments were carried out which included 53 fat and acidity determinations. The relation between the skim milk content of cream and the acidity was not entirely uniform, but since the fat content varied inversely as the skim milk content, a numerical relation between the acidity and skim milk content was determined. The average results, plotted with the acidity as the ordinate and the butterfat content as abcissa, gave a curve approaching a straight line. From this line, a constant (K) was calculated, which represented the decrease of acidity for each percentage of increase in butterfat in the cream. The value of K derived in this way was found to be 0.00128.

This constant may be applied by using the following formula:

$$x = a - [(c-m) \times 0.00128]$$

x = Acidity of cream desired
a = Acidity of milk
c = Per cent of fat in cream
m = Per cent of fat in milk

The accuracy of this constant was checked repeatedly and a comparison of the calculated acidity with the actual acidity is shown in the following table:

Trial No.	Acidity of milk	Per cent of fat in milk	Per cent of fat in cream	Calculated acidity	Actual acidity
1	.145	3.9	33.0	.108	.100
2	.149	4.0	36.0	.109	.110
3	.139	4.0	57.0	.071	.085
4	.133	3.5	55.0	.067	.073
5	.135	3.6	55.0	.069	.073

A Comparison of the Babcock and Roese-Gottlieb (Mojonnier) Tests for Butterfat in Milk.—A comparison of the Babcock and Roese-Gottlieb (Mojonnier) tests for butter fat in milk was carried out by C. A. Phillips. Fifty samples of a mixture of night and morning milkings were analyzed in duplicate by each method. It was found that the Babcock readings were higher in all samples, the minimum variation in butterfat readings being [illegible] per cent, the maximum .126 per cent, and the average .0588 per cent, when chemically pure sulfuric acid was used. Ten samples of milk tested by using both commercial sulfuric acid and chemically pure sulfuric acid showed readings slightly lower when the commercial sulfuric acid was used, but the difference was not great enough to be of importance. Glymol added to the tops of the fat columns of the fifty tests after the regular readings were made, gave readings .087 per cent lower than the average Mojonnier reading.

The Manufacture of Jack Cheese from Goat's Milk.—The manufacture of Jack cheese from goat's milk was studied by C. A. Phillips and C. E. Tegner. Ten vats of cheese were made following the process outlined in California Experiment Station Circular 206. From the work completed, it is evident that goat's milk can be made into a good grade of Jack cheese. The proportion of good, marketable cheese, however, is not sufficiently high to justify the commercial manufacture of Jack cheese from goat's milk until further work has been carried out.

A Comparison of the Spray and Flood Methods of Cooling Milk.—A series of sixteen tests were conducted by A. W. Farrell with a jacketed uninsulated 200-gallon glass enameled tank pasteurizer, to determine the comparative efficiency of the spray and flood methods of cooling milk. From the average of tests using the flood method, 1818 pounds of cooling water were required to cool 1000 pounds of milk from 142° to 110° F. In comparison, as was shown from an average of tests using the spray method, 1565 pounds of water were required, or a saving of 13.9 per cent, by the use of the spray method. This saving may be explained by the fact that each pound of cooling water absorbed more heat from the milk under the spray method since both the temperature rise and the percentage of heat actually absorbed from the milk were greater as compared to total heat absorbed. The temperature rise of cooling water with the spray method was 25.15° F., while with the flood method it was only 20.19° F. The heat actually absorbed from the milk by each pound of cooling water was 19.52 B.T.U. for each pound when using the spray method, as compared with 16.55 B.T.U. when using the flood method. The time necessary for cooling was 25.5 minutes with the spray method and 40 minutes with the flood method, or a saving of 36.2 per cent by the use of the spray method.

When the room temperature ranged between 80° and 90° F. instead of between 53° and 60° F., the efficiency of the spray method of cooling over the flood method was still greater. From the average of tests using the spray method, it will be seen that 1344 pounds of water were required to cool 1000 pounds of milk from 142° to 110° F., while by the flood method, 2079 pounds of water were required, showing a saving of 735 pounds, or 35.3 per cent, by the use of the spray method.

The temperature rise of the cooling water by the spray method was 27.5° F. and that of the flood method was 28.6° F., showing that more heat was carried away by the water with the flood method, but a comparison of the percentage of heat taken from the milk and the total heat carried away by the cooling water shows that only 50.65 per cent of the total heat carried away was taken from the milk, the remainder being taken from the air. By the spray method, 81.17 per cent of the total heat carried away was actually taken from the milk. The heat actually absorbed from the milk by each pound of cooling water was 22.39 B.T.U. with the spray method at an average room temperature or 85° F. and 14.47 B.T.U. with the flood method.

Comparing these results then with those taken at a lower room temperature, we find that the spray method is very much more efficient in regard to time and amount of water used, than is the flood method, and the advantage of the spray method increases as the room temperature increases, when an uninsulated tank is used.

Tests of Efficiency of Insulated and Uninsulated Concrete Milk Cooling Tanks.—In testing the value of insulated concrete tanks for maintaining milk at a

low temperature when held over night on dairy farms. A. W. Farrall used four uninsulated concrete tanks* with a capacity of four ten-gallon cans of milk, and a similar tank insulated with $1\frac{1}{2}$ inches of cork-board imbedded in the concrete which he filled 19 inches deep with water cooled to 50° F. The tanks were then left over night and at the end of fifteen hours the temperature of the water was taken.

A decided advantage in the use of the insulated tank was shown by a lower temperature rise, varying from 4.5 to 7.1° F. The difference between the temperature rise of the water in the insulated and uninsulated tanks was found to be greater with increased atmospheric temperature.

Bacteria Content of Strainer Cotton.—Ten samples of cotton, such as is used in filtering milk, were bought by C. S. Mudge on the open market. Eight of these samples were typical absorbent cottons, and two of them were of the grade known as hospital cotton. One gram samples were removed aseptically, placed in Petri dishes and nutrient agar poured over them. Five of these samples were found to be sterile and the remaining cottons had but few bacteria to the gram. Upon examination, these proved to be of the *bacillus subtilis* type and had a strong peptonizing action on the milk. From these observations, it can be seen that cotton, although not absolutely sterile, does not contribute materially to the bacteria found in market milk. Considering the weight of the cotton used in filtering milk to be about forty grams, it would be apparent that such a filter would distribute into the milk but a few hundred bacteria.

Use of Vacuum in the Manufacture of Butter.—A study of the churning of cream under partial vacuum has been carried on by G. D. Turnbow and L. A. Raffetto. It was shown that the length of time required to churn cream could be shortened by partial vacuum, but that unless the normal churning temperature was lowered, there would be a greater fat loss in the buttermilk. In all cases, the cream broke faster but the butter granules gathered slower with this method.

Duplicate churnings were made by selecting a quantity of pasteurized cream sufficient for two churnings. Half of the cream was churned by the usual method, and the remainder was churned under partial vacuum. Both sweet and neutralized cream was used. Butterfat determinations of the buttermilk were made by the Mojonnier method and samples of butter from each churning were scored three times at monthly intervals and held for future scorings. Since the quality of the cream in all churnings was very good, the butter scored higher than the average commercial butter. The butterfat globules in the buttermilk of vaccum churned cream, as shown by microscopic measurements, were uniformly larger than those in buttermilk of the usual churning.

The Butterfat Content of Various Parts of Bottled Milk.—An experiment was undertaken by C. L. Roadhouse and R. W. Clowes to determine the percentage of butterfat in the various parts of quart bottles of milk prepared from a mixture of the milk from several cows of each of the principal dairy breeds. Samples for analyses were taken one-half inch above the lower line of the cream layer; one-half inch below the upper line; one-half inch above the lower line of the milk layer; and one-half inch above the middle of the milk layer.

* All concrete tanks were 26 inches deep, the bottom of the tanks being set 13 inches beneath the floor level.

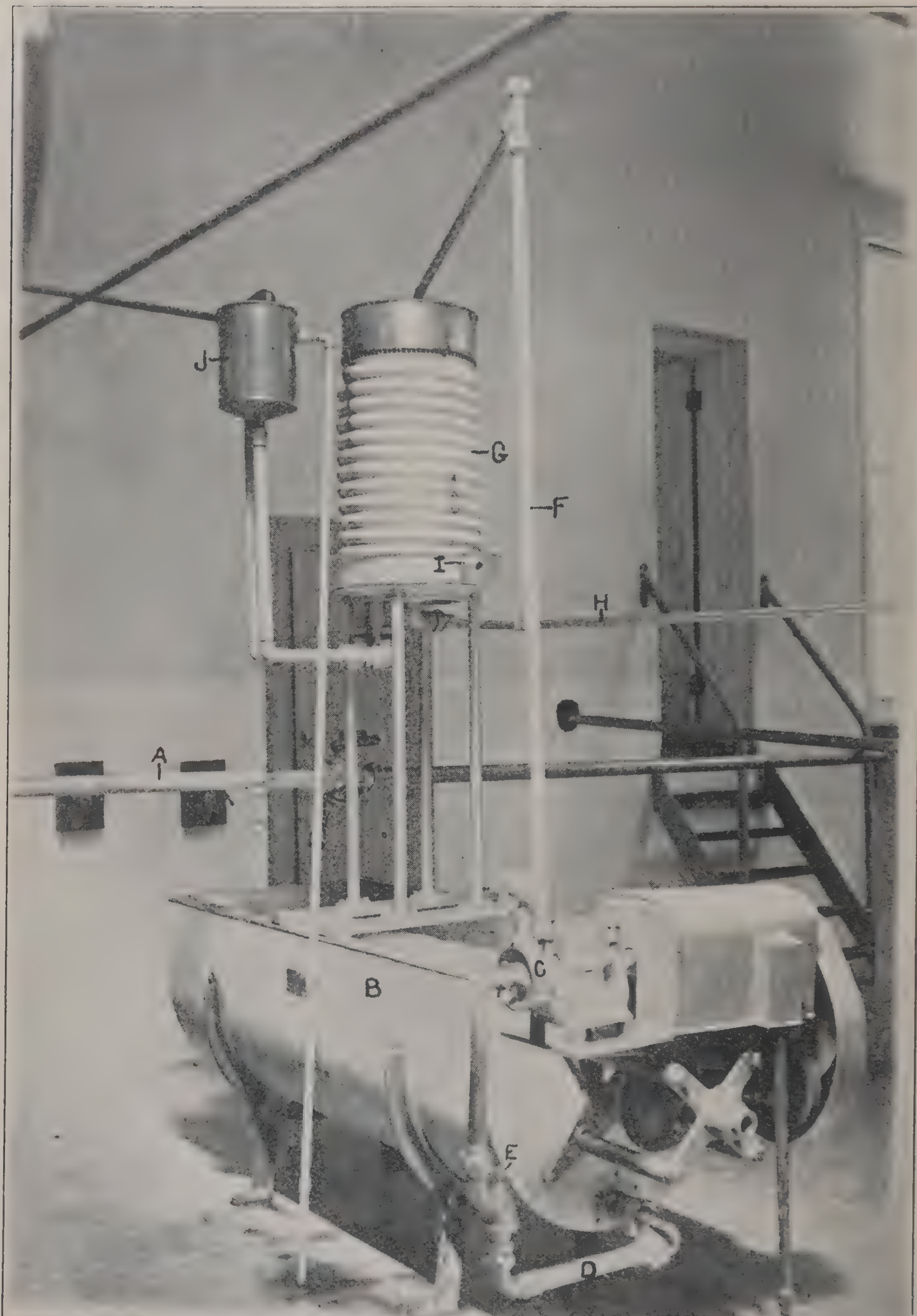


Fig. 55.—Flash heating of milk for separation. The whole milk from the receiving room, University Farm Creamery, flows by gravity through sanitary pipe "A," into vat "B," as shown in illustration. A revolving coil agitates the milk in the vat but does not heat it. The cold milk is drawn from the end of the vat by means of a sanitary milk pump, "C," through the pipe "D," with the valve "E" regulating the flow. The pump raises the milk through

The Jersey milk showed the highest percentage of fat in the cream layer, 21.5 per cent, and the lowest percentage in the upper, middle, and bottom portions of the underlying milk. The Ayrshire and Guernsey milk gave similar results. The percentage of fat in the cream layer of both of these breeds was lower than in the Jersey, being 19.33 and 19.66 per cent respectively, but the percentage of fat in the milk was higher than in the Jersey. The Holstein milk was similar to the Jersey milk in that it contained a high percentage of fat in the cream layer and a low percentage in the milk for all levels showing a more complete separation.

Samples from each breed were held at a temperature of 50° F. for twenty hours, and the butterfat of the upper and lower portions of the cream layer determined. The Guernsey showed the highest average for both the upper and lower portions, having 34.50 per cent of butterfat at one-half inch below the surface of the cream layer, and 20.75 per cent at one-half inch above the lower line of the cream layer.

The lowest average for the lower portion of the cream, 26 per cent, was that of the Holstein breed, while the lowest average for the upper portion of the cream, 19.75 per cent, was that of the Ayrshire breed.

The averages of the tests of the cream layer showed that the sample drawn from one-half inch below the top surface of the cream was high in butterfat for all breeds, varying from 25 to 36 per cent, while that drawn from one-half inch above the lower line of the cream layer showed approximately 20 per cent butterfat.

Butterfat determinations were also made of a mixture of the entire cream layer and a mixture of the milk layer of bottled milk for the different breeds, to gather such information as would be useful in preparing modified milk for infant feeding.

The Guernsey milk* showed the highest percentage of fat, 19.25 per cent, in the mixed cream layer and the Jersey sample gave the next highest testing cream layer, 18.87 per cent, and the lowest testing milk, 1.4 per cent. The Holstein milk showed a rather low percentage of fat in the cream layer, 17.37 per cent, and also in the milk, 1.65 per cent. The Holstein milk showed a more complete separation than would be expected, when it is assumed that cream with the largest fat globules should rise more quickly and completely.

In all cases, the percentage of fat in the lower half of the milk was less than in the upper half. This difference varied from .2 per cent to 2.2 per cent and averaged about 1 per cent. When milk was set at room temperature (65 to 75° F.) for twenty hours, there was a very slight difference in the results obtained when the bottles were set at 50° F. Milk placed in bottles for forty

* The fact that only one Guernsey cow was available for this comparison makes the result for this breed less dependable.

the pipe "F" and discharges it to flow by gravity over the milk heater "G." The milk heated to 100° F. then flows by gravity through the pipe "H" to the cream separator. An overflow pipe, "I," returns the surplus milk to the holding vat when the separator does not take the full amount passing over the heater; however, the regulation of the valve "E" prevents a continuous overflow. The water heater, "J," by means of a steam ejector, draws a constant flow of hot water through the milk heater. A circular metal cover placed around the heater assists in retaining the heat and prevents contamination from flies and dust.

hours at 50° showed a more complete separation of the cream than when held for shorter periods of time.

Influence of Temperature of Heating Media on Time Required to Pasteurize Milk.—The time required to heat milk to the pasteurizing temperature was determined by C. E. Tegner, using a jacketed glass enameled tank and applying water at different temperatures and live steam in the jacket. In every experiment, 1200 pounds of milk, agitated by a 12-inch propeller revolving 150 revolutions to the minute, was heated from 70° F. to 142° F. The time saved by using a high temperature heating medium was 9.5 minutes at 180° F., 24 minutes at 190° F., and 36.5 minutes with steam at 248° F.

Milk heated at each temperature was set in glass cylinders, and measurements of the cream layer showed that the use of steam with an average temperature of 248.7° F. for pasteurizing, produced a cream layer equal to that resulting from pasteurizing with water as the heating medium. Since steam held in the jacket at a pressure below five pounds to the square inch will heat milk faster than water used at 170°, 180°, 190° F., and also since the thickness of the cream layer is not lessened by this method of heating, it is believed that steam is more satisfactory to use for pasteurizing milk, when this type of apparatus is used.

University Farm Creamery.—The University Farm Creamery is operated to furnish facilities for the instruction of students; practical training for short course, non-degree, and degree students, and to supply materials and conditions for investigational work similar to those seen in commercial dairy plants. To meet these needs the University Farm Creamery manufactured during the year 112,136 lbs. of butter with an overrun of 23.64 per cent; 33,917 lbs. of cheddar cheese with a yield of 2.73 lbs. from each pound of fat or 10.6 lbs. of cheese from each 100 lbs. of milk; 4074 lbs. of jack cheese with a yield of 2.92 lbs. from each pound of fat or 11.4 lbs. of cheese from each 100 lbs. of milk; 116,381 lbs. of cottage cheese with a yield of 18.3 lbs. from each 100 lbs. of milk; and 3166 gals. of ice cream.

In addition to the above, a small quantity of club, brick, Neufchatel, and pimiento cheese was manufactured, and 9000 pounds of condensed ice cream mix was made.

One hundred and ninety-four of the churnings of butter made at the University Farm Creamery during the year had an average commercial score of 92.11 per cent. Laboratory examinations of the 233 total churnings showed an average moisture content of 15.21 per cent and salt 3.38 per cent. The 265,491 pounds of cream received for churning showed an average butterfat test of 34.1 per cent, and the milk received during the year had an average test of 3.8 per cent. The ice cream mix prepared at the University Farm Creamery is standardized to contain 10½ per cent fat; 10 per cent milk-solids-not-fat; 14½ per cent sugar, and ½ per cent gelatin. The University Farm Creamery sold and distributed to customers of the creamery and the city of Davis during the year milk equivalent to 140,981 quarts.

Testing Dairy Products.—Two hundred and sixty-six samples of dairy products were forwarded to the Dairy Industry laboratory from various dairy farms and plants and were analyzed by C. E. Tegner. These products included milk, cream, skimmilk, buttermilk, butter, cheese, ice cream, condensed skimmilk, and evaporated milk. The first four products named were examined for average butterfat contents, and the others for moisture content and total solids

as well as for butterfat. The average salt content of butter samples was 2.82 per cent, and the average casein content 0.65 per cent.

Scoring Dairy Products.—One hundred and seventy-eight samples of butter forwarded from commercial creameries in the state and scored by G. D. Turnbow and F. H. Abbott gave an average commercial score of 90.39 per cent. The 261 samples of butter forwarded by creameries coöperating in butter standardization gave an average score of 92.5 per cent.

Fig. 56.—Cheese Curing Room. The cheese curing rooms are equipped with galvanized pipe iron frames with brazed joints for shelving. Twenty-two pound Flats (A) and three-pound "Juniors" (B) are stored in this room.

State Fair Dairy Products Contest.—The Dairy Industry Division coöperated with the State Agricultural Society in conducting the State Fair Dairy Products Contest. There were 128 entries distributed as follows: butter, 24; cheese, 24; milk and cream, 80. The average score for the butter was 91.19 per cent, or .12 per cent higher than the average score for last year; for the cheese 89 per

cent, or 2.3 per cent lower than for last year; and for the milk and cream, 92.79 per cent, or 1.17 per cent higher than for last year. Samples were taken of 22 butter entries. The average analysis of the butter entries was: moisture, 13.8 per cent; salt, 2.3 per cent; curd, 1.4 per cent, and fat, 82.32 per cent.

Coöperating with City Health Departments, L. A. Raffetto scored the market milk supplies of Sacramento, Fresno, Oakland, Alameda, Richmond, Los Angeles, and Berkeley. The score was based on the bacterial content, sediment, bottle and cap, flavor and odor, fat, solids-not-fat, and acidity. Los Angeles showed the highest average score, 93.13 per cent, for 237 samples of milk, including Grade A raw, Grade A pasteurized, guaranteed, and certified Alameda was second with an average score of 92.4 per cent on 12 raw and pasteurized samples of milk. Richmond averaged 91.6 per cent on 8 samples of raw and pasteurized milk, while Berkeley scored an average of 91.5 per cent, and Oakland 88.5 per cent on 33 and 44 samples, respectively, including all four grades. Fresno, with 6 samples, and Sacramento, with 21 samples of Grade A raw, Grade A pasteurized, and certified, had average scores of 87.9 and 77.8 per cent, respectively.

Butter Standardization and Improvement.—Work with creameries in California was undertaken by F. H. Abbott beginning in July, 1922, for the purpose of standardizing and improving the quality of butter manufactured by such plants. The procedure in carrying out this work is as follows:

1. Creameries sign an agreement showing their desire and willingness to coöperate in producing uniform and better quality butter.

2. Samples are sent from every churning to the laboratory for analysis.

3. One pound of butter is sent to the laboratory at frequent intervals for commercial scoring.

4. Creameries receive instructions by letter and through personal visits to assist them to overcome difficulties encountered in the manufacture of butter.

RESULTS

Number of creameries now coöperating	26
Number of samples analyzed	3188
Number of samples given commercial score	261

Standards desired in composition and commercial score are:

Composition	
Moisture	14.5 to 16.0 per cent
Salt	2.5 to 3.5 per cent
Curd	less than 1 per cent
Fat	80 per cent or more

Commercial score	
Flavor	38 or better
Body	25
Color	15
Salt	10
Package	5
	93 or better*

* Butter scoring 93 or better is the highest grade and is known as an extra on the market.

That butter improvement is rapidly going forward is evident when a comparison is made of the composition of butter graded during the first two months and during the tenth month. Butter of the first two months contained 12.5 to 18 per cent of moisture, 1.45 to 6 per cent of salt, and .1 to 2.95 per cent of curd. Seventy-two per cent of butter samples examined during the first two months was below the desired standard of 80 per cent butterfat. During the tenth month, the composition ranged from 14.5 to 16.2 per cent of moisture, practically the standard desired; from 2.4 to 3.6 per cent of salt, as compared with the standard, 2.5 to 3.5 per cent; and .4 to 1.1 per cent of curd, as compared with the standard of less than 1 per cent. Moreover only .6 per cent of the butter examined fell below the desired standard for fat.

When comparing the quality of butter during the progress of the work, the results show that the average commercial score was 90 during the first two months and 92.5 during the tenth month, which approaches closely the desired standard of 93.

Butter scoring 92.5 will bring an average of two cents more on the market than 90 score butter. The annual output of the creameries now working on butter standardization and improvement is approximately 11,894,000 pounds. An additional two cents a pound represents an increased value of $237,880 per year. About one-half of the credit for the improvement shown may be attributed to better workmanship and one-half to the selection of the cream by grading. Creameries are given instruction in all branches of the work beginning with the grading of cream to finishing and packing the butter ready for the market. The butter from one creamery was of such poor quality in the beginning of the work that a commission man in San Francisco could not find a market for it. Six months later, the commission man reported that it was the best butter received.

Grading of Milk.—Experiments have been undertaken by C. S. Mudge to find quicker and more effective methods for determining the quality of milk. It was thought that perhaps there might be some relation between salts and acidity. Accordingly, samples of milk were titrated in two ways: (*a*) 100 c.c. of milk were titrated with N/10 NaOH, and (*b*) 100 c.c. of milk were titrated in the same way after the addition of 2 c.c. of neutral potassium oxalate. Charts were made on which (*a*) was plotted as an abcissa against the factor $\frac{A}{B}$ as an ordinate. Some interesting relations seemed to exist. Thus, with a milk of known good quality (by the usual tests) this point fell in a rather restricted area near the origin of the coördinates. But with a milk of a poorer quality, the plotted point fell in another portion of the chart. These relations generally existed in all of the milks brought to the University Farm Creamery. The kinds of bacteria, the kinds and amounts of salts in milk, the condition of the cow may all have a bearing on this relationship, and a problem of considerable magnitude might easily develop in following this project to its conclusion

ENTOMOLOGY AND PARASITOLOGY

The Peach-root Borer (*Aegeria opalescens* H. Edw.).—The use of paradichlorobenzene for the treatment of the peach-root borer, chiefly on apricot trees, has been continued under the direction of E. O. Essig and J. F. Lamiman.* During the past year approximately 3000 pounds were applied in doses of from three-fourths to one ounce to the tree in Alameda and Santa Clara counties. The results were entirely satisfactory and so encouraging that practically the entire acreage of infested apricot, peach, and other fruit trees will be treated similarly this coming fall.

In most cases the material was applied during September and October, but it may be used over a very long period in California because of the extended warm season. In not a few cases it was applied in December and remained throughout most of the winter, killing many of the borers and doing no damage to the trees. In one nursery a large number of young one-year-old peach buds were treated without injury. We are not yet fully satisfied as to the advisability of treating nursery stock with this material, for fear of injury to the trees but we hope to check over the results of the experiment again during the coming season. On the whole the use of paradichlorobenzene has entirely revolutionized the method of treatment for the pearch-root borer and is saving the farmers a great deal in labor and money. It is one of the most important pieces of work yet done in insect pest control.

The Mealy Bug in Pear Trees.—The use of the crude carbolic acid emulsion and miscible oils as recommended by E. O. Essig last year† was continued in the Santa Clara Valley with marked success and proves to be all that was reported and expected. Two or three applications during the winter months assures a thorough clean-up for the following season.

The Woolly Apple Aphis.—The work of J. F. Lamiman on the use of paradichlorobenzene for the control of the root form of the woolly apple aphis was continued in Sonoma and Santa Clara counties.* The material was applied late in the fall, from September to November, and was left around the trees for a period of two weeks, after which time the residue was removed. The percentage of infestation was reduced 75 to 95 per cent in most cases. Up to the present the treatment has shown no series effects to the trees. The amounts applied were from three-fourths to one ounce for four- to six-year-old trees and two ounces for large, mature trees.

The Pear Root Aphis.—The continued use of paradichlorobenzene for the control of the pear root aphis has given the same success as was reported by E. O. Essig last year.† The treatment of a large acreage in Contra Costa County last year resulted in thorough control without killing a single tree. The quickness and cheapness of this treatment make it readily accessible to the growers who were unable in the past to control the aphis.

---

* Report of the College of Agriculture and Agricultural Experiment Station, University of California, 1921–22, p. 189.

† *Ibid.*, p. 87.

Fig. 57.—Pear infested with Baker's mealy bug, showing deformation caused by the insect.

Codling Moth Control and Arsenical Residue.—Apples in northern Santa Clara County are subject to an infestation of the codling moth (*Cydia pomonella* Linn.), so heavy that it frequently affects 50 to 65 per cent of the crop. Much of the difficulty in control is attributed to the irregularity with which the first brood moths emerge. The life history as worked out during the past year by J. F. Lamiman showed that the first brood moths were still emerging on June 15, while the first of the second brood larvae were pupating the latter part of June. This indicates an oviposition period for the first brood moths lasting from May 15 to some time in July. The oviposition of the second brood moths began the first week in August and continued through September. Experimental work was begun in May, 1922, on winter apples after the growers had

Fig. 58.—Eggs of the garden centipede, *Scutigerella immaculata* (Newport). × 10. (Original.)

applied two sprays in attempting to control the first brood. Four additional sprays were applied, two in June and two in August, without materially reducing the infestation, but leaving at the same time a very heavy arsenical residue on the fruit (E. R. deOng). A thorough understanding of the life history of the insect would enable the grower to time his spray programme in accordance with the activity of the insect. If this were done, the latter applications might be omitted or smaller amounts of arsenic applied. Following this timing would also materially reduce the amount of the arsenic remaining on the fruit at harvest time.

Garden Centipede.—The garden centipede, *Scutigerella immaculata* (Newport), has caused great concern among the asparagus growers of the Sacramento Delta region. The white or canning asparagus is especially subject to injury, owing to the fact that this centipede feeds on the tender shoots below the surface of the soil. Much progress has been made in determining the life history of this pest as a basis for control work.

Field experiments with soil fumigants and insect repellents, such as lime, tobacco dust, ortho- and paradichlorobenzene, and other materials, are being conducted on Ryer Island by F. H. Wymore in coöperation with the California Packing Corporation.

In attempting to test recommendations for control by flooding, F. H. Wymore's experiment on the California Packing Corporation's ranch on Ryer Island was not successful for the reason that the small, temporary levees would not hold. However, Mr. Ed. Shelley, a farmer on Grand Island, has been quite successful for the past three or four years in controlling the centipede by flooding, using heavy, permanent levees with an abundant supply of cheap water.

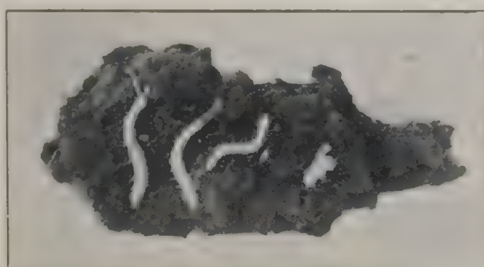


Fig. 59.—The garden centipede, *Scutigerella immaculata* (Newport). on the field pea. × 2. (After Essig.)

Fig. 60.—Lima beans showing the work of the garden centipede, *Scutigerella immaculata* (newport). × 2. (After Essig.)

Asparagus Beetle (*Crioceris asparagi* Linn.).—A study of this insect by F. H. Wymore showed that where previous recommendations were practiced, i.e., pulling and destroying all volunteer asparagus about the ditches and levees, and spraying the tops in the summer with arsenicals, satisfactory results were obtained.

Asparagus Miner (*Agromyza simplex* Loew).—In his study of this insect, F. H. Wymore found its distribution much wider and its responsibility for damage much greater than was suspected. He found that the maggots of this fly mine in great numbers just beneath the epidermis of the stalk in the soil. When full grown they pupate at the end of their galleries.

Fig. 61.—Asparagus shoot, showing the injury of the garden centipede, *Scutigerella immaculata* (Newport). A, showing marks on the surface of shoot; B, longitudinal section of shoot showing depth of penetration. Natural size. (After Woodworth.)

Artichoke Plume Moth.—Observations on the artichoke plume moth, *Platyptilia carduidactylia* Riley, continued this year by F. H. Wymore, have shown that the careful removal and destruction of all infested artichoke heads reduce the infestation to a minimum and that this practice offers the most economical means of field control.

Pea Aphis.—Field experiments with various dust preparations for the control of the pea aphis, *Macrosiphum pisi* (Kalt.) were conducted by F. H. Wymore. The dusts tested include 5, 7, 8, and 10 per cent nicotine sulfate (40 per cent), respectively. The latter two proved very satisfactory as a control factor. A self-mixing power duster with a long trailing canvas has been quite successful in the application of the dusts, at the same time reducing the cost from one-third to one-half. The trailing canvas adds greatly to the efficiency of the dust.

Calcium cyanid dusts have also been tested on the pea aphis. A control of approximately 90 per cent was secured with dusts containing 75 per cent and 100 per cent, respectively of the calcium cyanid containing 20 per cent cyanogen. In both cases slight foliage injury resulted. A 50 per cent dilution of the cyanid dust gave an estimated control of 75 per cent without injury to the foliage.

Natural Enemies of Beet Leafhopper (*Eutettix tenella* Baker).—Sugar company officials have frequently inquired as to the possibility of controlling the beet leafhopper (*Eutettix tenella* Baker) through the importation of natural enemies. In California a large number of predaceous and parasitic enemies attack

Fig. 62. The common asparagus beetle, *Crioceris asparagi* Linn., showing the various stages as they appear on the young asparagus shoots in the spring. × 2. (Original.)

the beet leafhopper. According to Mr. W. J. Hartung of the Spreckels' Sugar Company Agricultural Experiment Station, three predaceous bugs prey on the beet leafhopper: *Neides muticus* (Say), *Zelus socius* Uhl., and *Nabis kalmii* Reut. Spiders were observed by H. H. P. Severin feeding on the hopper in the beet fields. In the greenhouse, control measures must be adopted against the Argentine ant (*Iridomyrmex humilis* Mayr.) which enter the cages, kill the nymphs and occasionally the adults, and carry them to their nests. The green lacewing larva (*Chrysopa californica* Coq.) devours the hopper, and specimens of *Geocoris pallens* Stål collected in beet fields were frequently seen sucking out the juices of the nymphs and adults in cages. A reddish mite attached to the body of the beet leafhopper was sometimes observed.

The egg parasites bred from the eggs of the beet leafhopper in the San Joaquin Valley were as follows: *Polynema eutettixi* Girault (Figs. A, B). *Anagrus giraulti* Craw. (Figs. C, D), *Aphelinoidea plutella* Girault, and *Anthemiella rex* Girault. These egg parasites were reared more abundantly from eggs deposited by the beet leafhopper in saltbushes (*Atriplex*) than in sugar beets.

Two parasitic flies were bred from the beet leafhopper: *Pipunculus vagabundus* Knab (Figs. H, I), and *P. industrius* Knab. A wingless ant-like wasp (*Gonatopus contortulus* Patton (Fig. F) and the winged male (Fig. E) were bred from the beet leafhopper. The ant-like female is a very active creature, capturing and partly devouring a large number of hoppers. A single parasite emerging in a cage will kill most of the leafhoppers, but it is only in an occasional hopper that an egg is deposited. A parasitic hair-worm belonging to the Gordiacea (Fig. G) was dissected on rare occasions from the beet leafhopper collected at King City, Salinas Valley. The beet leafhopper was also parasitized by an occasional Stylops which was not bred.

In 1913 about 3.2 per cent and in 1914 about 33.6 per cent of the leafhoppers collected in beet fields were found to be parasitized by *Pipunculus vagabundus, P. industrius,* and *Gonatopus contortulus.*

During 1918–1920 a comparison was made of the percentage of parasitized beet leafhoppers collected on the plains and foothills with those captured in the cultivated areas of the San Joaquin Valley. Records obtained by dissecting the adults are more reliable than those secured by breeding the parasites, since a high mortality of the insects occurs in the breeding jars. The average percentage of parasitized adults of various broods of *Pipunculus* and *Gonatopus* was as follows: winter brood adults collected on plains and foothills, 4.4 to 8.2 per cent; winter brood adults captured in cultivated areas, 28 per cent; spring brood adults taken on plains and foothills, 1 to 1.5 per cent; spring brood adults caught in cultivated regions, 3.5 per cent; summer brood adults collected in cultivated districts, 10 to 32 per cent.

The weak point in the parasitism of the adults occurs on the plains and foothills. Dissections show that only those winter brood adults which are parasitized by a tiny larva fly to the foothills. This fact accounts for the extremely low percentage of parasitism of the spring brood. In the cultivated areas the percentage of parasitism gradually increases during the summer months and reaches its height during August.

Curly Leaf Transmission Experiments.—The question has frequently been asked whether the soil was becoming contaminated with curly leaf on account of plowing-under badly blighted sugar beets. Field and laboratory experiments demonstrate beyond any question of doubt that curly leaf is not transmitted through the soil or from beet to beet.

The infective principle of curly leaf is generally distributed in the foliage and beet root. After sugar beets had developed faint indications of the earliest symptom of curly leaf, namely the transparency of the minute veins on a portion of the youngest leaf, non-infected adults sometimes transmitted the disease by feeding on the outer leaves which showed no visible sign of the disease. The causative agent of curly leaf was transmitted to healthy beets when non-infective beet leafhoppers fed on the hairy rootlets, roots, and beet root of beets in an advanced stage of the disease.

The shortest time required for the infective principle of curly leaf to travel through a beet petiole seven inches long was one-half hour at a mean temperature of 103.5° F.

Infective beet leaf hoppers were placed on a beet seedling, feeding only on one of the outer or oldest leaves; and at the same time non-infective hoppers placed on the inner or youngest leaf of the same beet became infective at the end of two days, as was proven by transferring them to a healthy beet.

Chemical Substance or Toxin.—It is a well-known fact that suctorial insects inject into plants a chemical substance or toxin which may cause disturbance in the function or anatomy without the intervention of parasitic microorganisms. There is very little known concerning the secretion of poisons by suctorial insects and the effect of these poisons on plants.

Fig. 63.—The common asparagus beetle, *Crioceris asparagi* Linn., showing the four stages. × 5. (After Essig.)

Incubation Period.—Evidence accumulated during the past few years indicates that curly leaf is not produced by a toxin injected into the sugar beet by the beet leafhopper. It was impossible to eliminate the incubation period in the insect. We have failed to demonstrate up to the present time that curly leaf is transmitted by the beet leafhopper through external mechanical carriage, such as contamination of mouth parts. One hundred batches of twenty-five to fifty adults incubated for a period of one to three hours with the infective principle of curly leaf, failed to transmit the disease to 114 beets. In two experiments nine lots of from a hundred to a thousand nymphs or adults with an incubation period tested at two, three and four hours failed to communicate the disease to twenty-seven beet seedlings. Of [illegible] beets incubated for periods of four, five, six, and ten hours with the causative agent of curly leaf in the

beet leafhopper, fifteen typical cases of curly leaf developed. The four to ten hours may represent a mechanical internal transmission such as a regurgitation of the pathogenic factor rather than a biological internal transmission in which the infective agent develops or multiplies within the insect body. Leafhoppers with an incubation period of one, two, and three days transmitted curly leaf to 66.6, 85.2, and 88.8 per cent of the beet seedlings, compared with the result, 7.9 per cent incubated for a period of four to ten hours. The minimum incubation period in the sugar beet was reduced from three to two days in small beet seedlings. That a definite incubation period occurs in both the beet leafhopper and sugar beet, that the leafhoppers are non-infective upon hatching, that sometimes a single bite of an infective hopper causes in the beet changes which are entirely out of proportion to the minute quantity of secretion poured into the wound, are the greatest objections to the theory that a chemical substance or toxin is the cause of curly leaf.

Fig. 64.—Section of asparagus stalk, showing injury caused by the maggots of the asparagus miner, *Agromyza simplex* Loew, and the section removed to show location of the pupae. × 2. (Original.)

Bark Beetles of the Pine and Cypress.—A severe outbreak of bark beetles, *Dendroctonus valens* Lec., *Ips radiatae* Hopk., and *Ips phastographus* Lec., killed a large amount of standing timber in Monterey County. This was the result of cutting timber without working it up. Beetles bred in enormous numbers in this felled timber and then attacked and killed healthy trees. Under the direction of E. C. Van Dyke all infested timber was cut and destroyed before the spring flight of the beetles began, thus checking any further spread of the infestation.

Termites Attacking Power Line Poles.—A species of termite, *Reticulitermes hesperus* Banks, commonly attacks the base of poles where they are buried in the ground. The attack of this insect, accompanied by the work of wood decay fungi, results in the complete destruction of the lower part of the pole. Creosoting the base of the pole has been found by Van Dyke to be a good protection against this insect.

A second species of termite, *Kalotermes minor* Hagen, feeds on the top of the pole, honeycombing the upper part and at times the entire pole. This species is independent of moisture and is able to maintain itself in the driest wood. This insect is much more difficult to combat than the former termite, for

creosoting the base is no protection against its entrance. It has been recommended (E. C. Van Dyke) that the entire upper portion of the pole be soaked or painted with an arsenical solution.

Fig. 65.—Artichokes showing injury caused by the larvae of the artichoke plume moth, *Platyptilia carduidactyla* Riley. Slightly reduced. (After Essig.)

Poultry Round Worm Investigations.—The control of the poultry round worms has been carefully investigated by S. B. Freeborn during the past year. Nicotine remains the most satisfactory drug for the elimination of these worms. Tobacco dust which contains from $1\frac{1}{2}$ to 2 per cent nicotine fed as 2 per cent of the dry mash daily for three or four weeks removes approximately 100 per cent of the large intestinal worms (*Ascaridia galli* Schrank) and 85 per cent of the cecum worms (*Heterakis gallinae* Gmelin.). Nicotine sulfate used with the

food or water or water of the birds is not acceptable, but combined with Lloyd's Alkaloidal Reagent at the rate of 6.6 c.c. to 16 grams of the reagent and administered in single doses of 350 milligrams (No. 2 gelatine capsule), the single treatment is nearly 100 per cent effective for the large worms (*Ascaridia*) though it is ineffective for the cecum worms (*Heterakis*). Rectal injections of ten cubic centimeters of ½ per cent solutions of nicotine sulfate (40 per cent nicotine) in distilled water removes 85 per cent of the cecum worms. On account of the relationship which the cecum worms bear to the organism which causes "blackhead" of turkeys, projects are under way to determine the possibility of protecting flocks from this disease by constant feeding of tobacco dust.

Nicotine as a Parasiticide.—A study of nicotine as a parasiticide was made by E. R. deOng and S. B. Freeborn. The object sought was to obtain a stabilized and standard nicotine dosage that would be effective as an anthelmintic without being injurious to the fowl. Tobacco dusts stored in open sacks have been observed to lose from 12 to 14 per cent of their nicotine content in one month. Acidifying tobacco dusts with sulfuric and hydrochloric acids retarded this loss approximately one-half. The most stable carrier for nicotine was found to be an aluminium silicate known as Lloyd's Alkaloidal Reagent. Fuller's earth, diatomaceous earth, and other powders were tested as carriers but were found to release the nicotine quite rapidly.

The increased toxicity of free nicotine over that combined with an acid, as shown in insecticidal experiments, was confirmed by tests on the chicken, for 100 mg. of nicotine sulfate could be given with impunity in distilled water while 10 to 65 mg. of free nicotine caused death. A dosage of 3 mg. of free nicotine was the minimum at which death might occur.

Study of Nicotine as an Insecticide.—A close correlation between the volatility and toxicity of nicotine has been shown by E. R. deOng. Experiments with nicotine sulfate solutions in distilled and tap water, with and without the addition of varying amounts of alkali, have shown an increase in toxicity to aphis corresponding to the degree of alkalinity present. Solutions containing sufficient alkali completely to free the alkaloid nicotine from the sulfuric acid showed an average increase in efficiency of 22.7 per cent by spraying and 40.3 per cent by fumigation experiments over neutral or acid solutions of nicotine sulfate.

Fumigation experiments with the same solutions used in spraying showed an efficiency curve that closely paralleled that of spraying. This indicates that the insecticidal action of nicotine is due to the volatile portion, and that it is a "respiratory" rather than a true contact poison.

The rate of loss of nicotine from sprayed foliage, as determined by chemical analysis, confirms the theory of an intimate correlation between volatility and toxicity. In clear, dry weather 38.1 per cent more nicotine was recovered from foliage sprayed with a neutral solution than was found by spraying with nicotine in alkaline solutions. During cloudy, rainy weather a difference of 67.1 per cent was found between the loss of nicotine from neutral and from alkaline solutions.

Besides the functions of a "respiratory" poison, nicotine has a second function, i.e., as a repellent for caterpillers or other plant-feeding insects. These two functions are of opposite character. As a respiratory poison its efficiency is increased by a quick release of the maximum amount of the alkaloid, while as a repellent its action is lengthened by slow volatilization.

Fig. 66.—Egg parasites of beet leafhopper (*Eutettix tenella* Baker): A, male, B, female of *Polynema eutettixi* Girault; C, male, D, female of *Anagrus giraulti* Craw.; parasites of nymphs and adults, E, male, F, female of *Gonatopus contortulus* Patton; G, Hairworm (*Gordiacea*); H, male, I, female of *Pipunculus vagabundus* Knab.

Insecticidal Value of Derris.—Spraying and dusting with the Indian fish poison plant (*Derris* spp.) have been made by a senior student, L. T. White, under the direction of E. R. deOng. An extract of this plant known as Derrisine was unsatisfactory as an aphicide. Dilutions of 1 to 300 gave a 68 per cent efficiency while 1 to 500 gave a control of but 50.5 per cent. It was also found inefficient against the red spired *Tetranychus telarius* Linn.

A dust made from ground Derris root mixed with 80 per cent of inert carrier was tested by a senior student, L. T. White, under the direction of E. R. deOng, and found to give perfect control on the biting lice, *Menopon biseriatum* Piaget and *Goniocotes gigas* Taschenberg, of the fowl and on the sucking lice, *Gyropus ovalis* Nitzsch. and *Gliricola porcelli* Linn., of the guinea pig.

Bee Diseases.—Experimental work on the control of diseases of adult and larval bees is being caried on by G. H. Vansell at the University Farm, Davis. The eradication of the causative organisms of foul brood without the destruction of the brood combs is being attempted by means of chemical treatment. An investigation of the so-called "Buckeye Poisoning" of bees is being conducted in coöperation with certain individuals and with the Napa County Beekeepers' Association.

Adaptation of the Honey Bee for Cross-pollination of Deciduous Fruit Bloom.—A study (E. R. deOng) of the native species of California bees including the bumble bee, *Bombus* spp., carpenter bee, *Xylocopa* spp., and the mining bee, *Megachile* spp., shows that almost without exception they are either hibernating or so depleted in numbers during the blooming season of deciduous fruit that they are of little value as cross-pollinators. This indicates that fruit trees are even more dependent on the presence of the honey bee in large numbers than is generally recognized.

The record of flights at the hive entrance as kept by University students in apiculture shows that the activity of the bee is closely coördinated with the temperature at which fruit trees bloom. Activity of the field bees is common by the middle of February, becoming more pronounced by the end of the month, the blooming time for the almond. Increasing activity is noticed during March, the blooming period for peaches, plums, cherries, and the first of the apples and pears. Brood rearing usually begins sufficiently early so that the number of field bees is very much increased by the height of the blooming season. This makes possible a large number of bees for cross-pollination work at the critical time.

The Pajaroello Tick.—Field and laboratory observations concerning the venomous Pajaroello tick (*Ornithodorus coriaceus* Koch) were continued by W. B. Herms, assisted by L. K. Wilson, a graduate student. Trips to Mount Hamilton, where the species flourishes, indicate that under field conditions egg deposition takes place during June and July in the deer beds of that region, among the low scrub oak (*Quercus dumosa* Nutt.). Myriads of larvae were observed during the months of July and early August, but after this time no more were found. Although it is not definitely known, it is assumed that the deer of that locality serve as hosts for the larvae as well as for the adults.

FARM MANAGEMENT

Cost of Producing Market Milk and Butterfat.—A year of record taking by R. L. Adams and his associates on 246 dairies located in eleven important dairying sections of the state and having a total of 14,250 cows shows production costs to be as follows: Humboldt–Del Norte, $2.73 per 100 pounds of whole milk or 61.2 cents per pound of butterfat; Marin–Sonoma, 49.2 cents per pound of butterfat; Alameda–Contra Costa–Santa Clara, $2.83 per 100 pounds of whole milk (24.4 cents per gallon); Sacramento–Yolo, $2.46 per 100 pounds of whole milk or 64.2 cents per pound of butterfat; San Joaquin–Stanislaus, $2.63 per 100 pounds of whole milk or 65.3 cents per pound of butter fat; Fresno, $2.34 per 100 pounds of whole milk or 60.2 cents per pound of butterfat: Kern, $2.23 per 100 pounds of whole milk or 50.1 cents per pound of butterfat; Los Angeles–Orange, $3.73 per 100 pounds of whole milk or at the rate of 97 cents per pound of butterfat contained therein; San Diego, $3.67 per 100 pounds of whole milk or at the rate of 86 cents per pound for its butterfat content; San Luis Obispo, 53.6 cents per pound of butterfat; Monterey–SanBenito–Santa Cruz, $2.54 per 100 pounds of whole milk or at the rate of 70 cents a pound for butterfat.

Investment in Dairy Buildings for Each Cow.—From a study of the data collected during the investigation into the costs of producing whole milk and butterfat, R. L. Adams found that the average investment in dairy buildings for each cow varied in different localities. By districts, the average investment was found to be: Humboldt Del Norte, $42.19; Marin-Sonoma, $51.65; Alameda Contra Costa Santa Clara, $76.59; Sacramento-Yolo, $75.23; San Joaquin–Stanislaus, $79.65; Fresno, $40.14;; Kern, $38.23; Los-Angeles-Orange, $48.37. San Diego, $54.79; San Luis Obispo, $38.01; Monterey San Benito Santa Cruz, $59.34.

Investment in Dairy Equipment for Each Cow.—The investment for each cow required in dairy equipment in each of the different localities where cost data were obtained was found to be as follows: Humboldt Del Norte, $8.18; Marin Sonoma, $12.95; Alameda–Contra Costa–Santa Clara, $11.42; Sacramento-Yolo, $5.41; San Joaquin–Stanislaus, $11.82; Fresno, $11.32; Kern, $9.52; Los Angeles–Orange, $5.65; San Diego, $15.69; San Luis Obispo, $11.33; Monterey–San Benito–Santa Cruz, $9.

Labor and Feed Largest Items in Cost of Producing Milk.—The percentages of total cost attributable to labor and feed cause these two items to be the largest factors in the expense of producing milk. By districts the proportion of total cost due to labor and feed was found to be as follows:

District	Labor Cost Per cent	Feed Cost Per cent	Total cost due to labor and feed Per cent
Humboldt–Del Norte	31.2	54.5	85.7
Marin–Sonoma	24.8	53.3	78.1
Alameda–Contra Costa–Santa Clara	29.4	45.5	74.9
Sacramento–Yolo	28.6	47.2	75.8
San Joaquin–Stanislaus	31.5	42.0	73.5
Fresno	30.0	45.9	75.9
Kern	30.4	52.0	82.4
Los Angeles–Orange	20.9	56.5	77.4
San Diego	26.7	51.8	78.5
San Luis Obispo	37.4	43.5	80.9
Monterey–San Benito–Santa Cruz	29.3	53.1	82.4

Production Averages for Each Cow.—Based on all cows maintained as a part of the milking herds and averaged for a full year, the average production of each cow in eleven districts was found by R. L. Adams to be:

AVERAGE PRODUCTION PER COW IN POUNDS

District	Whole milk	Butterfat
Humboldt–Del Norte	5,901	259.1
Marin–Sonoma	4,911	216.1
Alameda-Contra Costa–Santa Clara	7,180	....
Sacramento–Yolo	6,614	230.5
San Joaquin–Stanislaus	6,710	270.3
Fresno	6,793	237.8
Kern	5,993	234.4
Los Angeles–Orange	8,041	309.2
San Diego	6,225	267.0
San Luis Obispo	4,239	161.3
Monterey–San Benito–Santa Cruz	6,829	248.0

Dairymen's Estimates of the Value of Manure.—Estimates of the value of manure produced by each cow in the milking herd during the year was found to vary from 33 cents a head recorded for San Luis Obispo County district to $12.54 for the Los Angeles–Orange district. Of the eleven districts, averages from four amounted to less than $2.50 annually per animal; five were from $2.50 to $9, while the remaining two estimated the value at a figure in excess of $9.

Mortality of Dairy Cows.—Investigations in cost data by R. L. Adams show that death losses of dairy cows ranged from 2.3 per cent to 5.95 per cent of the average number maintained in the herds, or a general average based on the 14,250 cows studied of 3.8 per cent.

Milk Sold Below Cost of Producing.—In the study of the cost of producing market milk and butterfat, R. L. Adams collected complete and usable data from dairies located in eleven districts, thus: Humboldt–Del Norte, 25; Marin-Sonoma, 19; Alameda–Contra Costa–Santa Clara, 20; Sacramento–Yolo, 41; San Joaquin–Stanislaus, 17; Fresno, 17; Kern, 15; Los Angeles–Orange, 40; San Diego, 13; San Luis Obispo, 20; and Monterey–San Benito–Santa Cruz, 19.

The percentage of the total output of each of these groups placed on the market at costs in excess of the average price received by the group during the year 1922 was found to be: Humboldt–Del Norte, vicinity of Arcata, 100 per cent, Orick–Requa district, 83.6 per cent of butterfat and 84.7 per cent of whole milk; Marin–Sonoma, 59 per cent of the butterfat sold; Alameda–Contra Costa–Santa Clara, 70 per cent of the whole milk sales; Sacramento–Yolo, 92 per cent of the butterfat and 76 per cent of the whole milk; San Joaquin–Stanislaus, 56 per cent; Fresno, 49.2 per cent of the butterfat and 44.4 per cent of the whole milk; Kern, 30 per cent of the butterfat and 26 per cent of the whole milk; Los Angeles–Orange, 65.9 per cent of the milk sold; San Diego, 37.8 per cent of the milk sold; San Luis Obispo, 60 per cent of the butterfat sold; and Monterey–San Benito–Santa Cruz, 90 per cent of both butterfat and whole milk sales.

Place of Tenancy in California Agriculture.—That tenancy is an economic factor in California agriculture and yet does not lead generally to ultimate ownership is the conclusion of R. L. Adams, following the close of a five-year study of farm leasing methods. Reasons for tenancy are set forth as better utilization of lands and labor, increased community earnings, higher land values, farming opportunities with limited capital, promoting development of lands, and larger returns to landlords. Objections include danger of soil deterioration, chance of poor farming, neglect of land, buildings, and equipment, exporting of earnings, postponement of subdivision, retardation of coöperative movements, and possible social disadvantages attaching to tenancy.

Terms of Leases.—From a study of 407 leases, detailed field investigations in selected districts, and a field survey conducted in twenty-seven counties (in coöperation with the Commonwealth Club of California, with headquarters in San Francisco) R. L. Adams gathered data concerning methods used in leasing California farms. Some of the findings are indicated in the following paragraphs.

Tenanting of orchards and vineyards is not common. When practiced, the annual lease on a share basis is favored. The landlord commonly supplies orchard, buildings, workstock, implements, and other equipment for handling the trees or vines and the resulting crops. A share of one-half of the gross output is the usual method of taking care of the rent.

Leases of lands for field crop production include many leases made on a cash basis, though the share method is also often followed. Annual leases are the rule, and, if on a share rent basis, usually provide that the landlord shall receive from one-quarter to one-half the crop, the amount depending on the character of the land, the expense of handling the crop, and the items that the landlord supplies.

Leases of dairy farms are common and variable. Leases of from three to five years are frequent, payments for rent being upon either a cash basis, for a fixed lump sum for the entire farm or upon an acreage basis, or else for a share of the dairy output and calves. A few dairies are rented by the year on a basis of a stated cash rent for each cow. The landlord supplies land, buildings, and sometimes pays a part of the operating expenses. Cows are supplied either jointly by landlord and tenant or else by either party. The manner of meeting the needs of the dairy determines the rental rates, although if the share method be employed, the tendency is to work out a plan by which each party shall share equally in the output. One-third, two-thirds, or other figures are occasionally used in stating the landlord's share.

Leases of livestock ranges are variable in character. Cash rents are common, although share renting is practiced to some extent. Length of leasing varies from one to fifteen years, with a majority of the leases running for two, three, four, or five years, since stockmen, as a rule, are opposed to a short-term contract.

Very little leasing of poultry farms was found, owners preferring either to manage their property in person or else to sell out.

FORESTRY

Redwood Yield Tables.—Preliminary yield tables for second growth redwood have been prepared by D. Bruce. The basic data consist of 135 sample plots well distributed throughout the redwood region from Santa Cruz to Del Norte County. Five site qualities were recognized, but the tables cover only the three better sites. On all sites the species is found to grow with remarkable rapidity. At fifty years of age the fully stocked stands produce from 76,000 board feet (International Rule) to the acre on site three, to 116,000 board feet on site one. On site two, at fifty years of age, over one-half of the volume is in trees 20 inches and over in diameter and 110 feet in height. while about a quarter is in trees 25 inches and over in diameter and of approximately the same height. The presence of small proportions of such other species as Douglas fir or Sitka spruce apparently has little effect on the volume yield.

Time Studies of Logging.—D. Bruce has completed two further studies* on the effect of tree diameter on the cost of donkey yarding of logs. The conclusion is in each case confirmed that it is exceedingly expensive to handle small trees by methods suitable to large timber. Detailed data were collected on 1141 and 1349 trips, respectively, of the yarding line, in which a total of about three and a third million feet of timber were hauled. The two studies were made under radically different timber and operating conditions, yet the results are in both cases nearly identical with those previously reached, i.e., that it costs seven to eight times as much to the thousand, to yard the logs from trees 18 inches in diameter as those from trees 48 inches in diameter.

Redwood Seed Study.—H. C. Lott, Bidwell Research Assistant in Forestry working under W. Metcalf's direction, made an intensive study of production and viability of the seed of *Sequoia sempervirens* produced in 1922. Cones were collected in Humboldt, Mendocino, Sonoma, Marin, Contra Costa, and Santa Cruz counties, representing as many different sites and age classes as possible. After extraction, cutting and germination tests under controlled temperature conditions were carried on. Some of the important conclusions may be stated as follows:

1. Seeds collected before August 17, though apparently well filled, are not ripe enough to give any germination. In 1922, seeds collected September 21 gave as high germination as those taken from the same trees two months later. Maturity of seed cannot be accurately determined by cutting sections through the cones. A yellowish color or a slight separation of cone scales are indications that the seeds are fully ripe. December 1 marks the end of the period for seed collection, as at this date practically all cones have lost their seed.

2. On the basis of all samples collected, nine pounds of green cones averaging 227 cones to the pound are required to produce one pound of clean seed. The average cone contains 60 seeds. The number of clean seeds to the pound varies in individual samples from 59,000 to 300,000, the average being 123,310.

3. Seed extraction at room temperature with good aeration supplied by an electric fan requires a period of from ten to fourteen days. The average loss of moisture in drying is 56.8 per cent of the green weight of cones.

---

* Report of the College of Agriculture and Agricultural Experiment Station, University of California, 1921–22, p. 95.

Fig. 67.—Second growth redwood yield study. North Fork of Gualala River. A [illegible]-year old stand of pure redwood—56,000 board feet per acre.

4. The per cent of viability of the seed increases with the age of the tree, reaching the maximum some time after 250 years. Seed produced by trees of the first age class (1–20 years) is generally less than 1 per cent viable, while that from very old trees (1500 years) is sterile or less than 3 per cent viable. The largest seed collected in 1922 came from trees 60–100 years old.

5. As seeds of different size show consistent differences in the cutting test, total viability, and rate of germination, it is advisable to separate redwood seed into classes of two sizes and to sow these separately. This can be done conveniently by shaking the seed through standard copper wire screens which have eight and ten wires respectively to the inch. The viability of seeds which pass through screen No. 10 is usually so low that they can be discarded. Experiments show that the average germinative energy period in moist blotters at 20° C. is 35 days, but that it may vary from 15 to 50 days in individual samples.

6. The seed collected in Mendocino County was of much better quality than that from any other locality. Even the No. 12 seed showed a germinative capacity approximately as great as that of Nos. 8 and 10 in these samples.

7. Germination of redwood seed is not hastened by soaking in warm water or by treating with dilute sulfuric acid. Seed soaked in water at 65° C. for 15 minutes is no longer viable.

8. High specific gravity is not an indication of good viability in redwood seed. There is apparently no relation between specific gravity and the germination per cent.

Eucalyptus Studies.—W. Metcalf has made taper measurements on 123 felled *Eucalyptus globulus* trees from which he compiled the following form factor table, showing the relation between tree volume—including bark, excluding a one-foot stump, and used down to a diameter of 2 inches in the top—and that of a cylinder having a diameter equal to the breast high diameter of the tree and a height equal to its total height.

FORM FACTOR TABLE FOR *Eucalyptus Globulus*

Diameter breast high	Form Factor	Diameter breast high	Form Factor
2 inches	.480	15 inches	.388
3 inches	.472	16 inches	.381
4 inches	.466	17 inches	.374
5 inches	.458	18 inches	.368
6 inches	.451	19 inches	.361
7 inches	.444	20 inches	.354
8 inches	.436	21 inches	.347
9 inches	.428	22 inches	.340
10 inches	.420	23 inches	.333
11 inches	.413	24 inches	.325
12 inches	.406	25 inches	.318
13 inches	.400	26 inches	.311
14 inches	.393	27 inches	.303
		28 inches	.294

From the form factors above the following table for computing eucalyptus volume has also been derived by multiplying the square foot area of the section at each breast high diameter by the form factor corresponding to that inch class. To obtain the volume for any eucalyptus, it is only necessary to measure its diameter breast high and its total height. Reduce the breast high diameter measurement to the nearest even inch and multiply the figure corresponding to

that inch class in the table by the height of the tree. The figures will not be accurate when applied to single trees but should give an approximately accurate total when used for a number of trees.

TABLE FOR CALCULATION OF EUCALYPTUS VOLUME

Diameter breast high	Multiplier	Diameter breast high	Multiplier
2	.0105	15	.4760
3	.0232	16	.5320
4	.0406	17	.5899
5	.0623	18	.6500
6	.0885	19	.7101
7	.1185	20	.7748
8	.1521	21	.8350
9	.1893	22	.9160
10	.2286	23	.9649
11	.2722	24	1.022
12	.3182	25	1.083
13	.3689	26	1.148
14	.4200	27	1.206
		28	1.258

The results obtained will be the volume of the tree in solid cubic feet. To reduce to standard cords (128 stacked cubic feet) divide the above result by 90.

Thinning Stands of Redwood Second Growth.—In order to determine the influence of different methods of thinning on the rate of growth and development of redwood in second growth stands, W. Metcalf has laid out permanent sample plots on Smith Creek, Mendocino County, and in Arcata City Park, Humboldt County. Establishment of these plots was made possible through the interest and coöperation of the Union Lumber Company and the City Council of Arcata.

The Smith Creek plot was laid out in a representative stand of second growth coming up on land logged in 1917. The size of the plot, which is only three miles from the ocean, is approximately one acre. All of the trees growing on it were carefully measured, and one half the area was thinned so as to leave about eight to ten of the best sprouts to the stump, distributed at about equal distances around each stump. The other half of the plot was not thinned and will be used as a check on future growth in the thinned portion. The character of growth on the thinned portion of the plot may briefly be presented as follows:

Smith Creek, Plot I

Age of sprouts, 5 years.
Area of plot, 0.607 acres.
Number of redwood stumps per acre, 46.
Average diameter of stump, 35 inches.
Number of sprouts per stump, 72.
Number of sprouts per acre, 3337.
Average height of dominant sprouts, 15.5 feet.
Average diameter breast high of dominant sprouts, 2.3 inches.
Sprouts less than 3 ft. in height: 92 per acre = 3 per cent.
Sprouts 3 to 6 ft. in height: 1100 per acre = 32.9 per cent.
Sprouts over 6 ft. in height: 2145 per acre = 64.1 per cent.
Approximate percentage of total ground area occupied by sprout clusters, 10–15 per cent.
Number of trees left after thinning—8 per stump = 385 per acre.
Average size of trees left = 1.9 inches diameter breast high and 14 feet high.

The origin of sprouts, as indicated by a record of those left after thinning, is as follows: root crown sprouts (originate near the base of the stump), 55.1 per cent; root suckers (originate at some distance from the stump), 25.8 per cent; side sprouts (originate from side of stump above ground), 18.6 per cent; crown sprouts (originate from top of stump), 0.5 per cent.

The following secondary species were also found on the area but are much smaller than the redwood sprouts: tanbark oak 6, California nutmeg 5, lowland white fir 5, and Douglas fir 2, per acre.

Two sets of plots were laid out in the Arcata City Park, which is covered with a mixed stand of second growth forty-six years old. In the first of these, the thinning was from below so that only trees in the lower crown classes were removed. In the second, the thinning was from above so that the experiment might possibly demonstrate the influence upon redwood of the removal of competition from overtopping trees of Douglas fir and white fir.

Fig. 68.—A cluster of five-year-old redwood sprouts after thinning in October, 1922. On the average, eight of the best sprouts to the stump were left.

The character of the stand of timber in this area is indicated by a 25 per cent cruise made by F. X. Schumacher and D. Bruce in 1922.

The stand is 46 years old, there were 157 redwood to the acre, showing 30,800 board feet; 12 Sitka spruce, showing 5890 board feet; 12 white fir, showing 5180 board feet; 5 Douglas fir, showing 2610 board feet; and 8 hardwoods (alder and maple), showing 446 board feet.

On Plot I (½ acre), 50 trees, or a total cubic volume of 679.05 cubic feet, were marked for thinning from below. These were distributed as follows: 35 redwood with total cubic volume of 467.60 cubic feet; 7 Sitka spruce with total cubic volume of 133.83; 3 Douglas fir with a cubic volume of 23.11; 5 red alder with a total cubic volume of 54.51. This thinning has disturbed the crown cover very little, as most of the trees removed were in the intermediate or suppressed crown classes.

On Plot II (½ acre), 10 trees with a total cubic volume of 1243.48 cubic feet were marked for thinning from above. Of these 6 were Douglas fir, having a total cubic volume of 739.43, and 4 were white fir, having a total cubic volume of

503.95. This thinning has released the redwoods from very serious overhead competition and should result in a marked increase in their rate of growth.

Range Investigations.—The demand for pasturage on California ranges generally is greatest in winter and early spring. Accordingly, the range investigations now under way by A. W. Sampson are confined largely to the foothill lands. The studies being conducted are chiefly of the following nature:

1. Native forage grasses: their life history and forage value.
2. A survey of California's grazing types with suggestions as to their management.
3. Artificial reseeding of depleted grazing grounds.
4. Natural revegetation and maintenance of the foothill ranges.

Native Forage Grasses.—Range grasses, because of their ability to withstand grazing, their comparatively high nutritive qualities, and the yield stability of the perrenial forms from year to year, constitute the most important family of

Fig. 69.—A typical stand of five-year-old redwood second growth in Mendocino County. It averages over 3300 sprouts to the acre. Only about 15 per cent of the area is occupied by the densely clustered sprouts. This fact emphasizes the need for planting on redwood cutover lands.

plants on the range. As one of the steps toward better range management, it is important that stockmen and students of range management problems recognize the more valuable range grasses. To this end there is being prepared for publication by A. W. Sampson plant descriptions and highly popularized illustrated keys of the more important grass tribes and genera, accompanied by notes as to the forage value, growth requirements, and distribution of species of first pasture rank.

Range Types and Their Management.—As a preliminary study to the range and livestock management problems as a whole, it is imperative that a survey be made of the state's grazing resources. The data are being collected by A. W. Sampson according to such major forage units as (1) timber lands, (2) brush areas, (3) grass lands, and (4) desert. Outstanding sub-types occurring within the larger units are recognized. The factors which are given special consideration are:

1. Character and comparative grazing value of the respective forage types.

2. Present and potential grazing capacity.

3. The more important forage species, poisonous plants, and indicators of range depletion.

4. Proper period of forage use and length of the grazing season.

5. Abundance and distribution of stock water and practicability of further water development.

6. Management of the respective forage types on the basis of a sustained annual yield.

In addition to the study of general management plans of the forage types, the survey will make available a forage type map of the state which should be valuable in the pursuit of range research and in grazing administration in the future. The investigation is being conducted in coöperation with the United States Forest Service.

Fig. 70.—A sparse, weak stand as seen on March 14, 1923, of native grasses, bur clover, and alfilaria in association with unpalatable weeds of an average height of one inch. For many years past, the ranch owner had grazed the area throughout the entire growing season, thus preventing the formation of a seed crop. Realizing the need for improved forage conditions, the owner this year resorted to a new grazing plan.

Artificial Reseeding of Range.—In localities where the soil has not been seriously impaired, but where the better native forage species have been all but eliminated by excessive cropping, seeding with introduced grasses and legumes may be economically possible. In the region of the so-called "fog belt," inland only a few miles from the coast, and possibly in restricted localities elsewhere, artificial reseeding may find a permanent place in the management plans. While by far the greatest possibilities of range regeneration lie in the field of natural reseeding, it is probable that by selecting heavy-yielding, perennial, cultivated species much additional pasturage may be obtained. The best results from artificial reseeding may be expected by scattering the seed when the fall rains begin. Because of their greater permanance and their ability to withstand trampling, the more palatable and nutritious turf-forming species will be included in the experiment.

Natural Revegetation and Maintenance of Foothill Ranges.—The natural revegetation studies require that both general and intensive investigation be conducted over a wide range of forage types and climatic conditions. Much of the detailed study by A. W. Sampson is being conducted in Shasta County, but the investigations are being extended to the counties of Santa Barbara, Tulare, and certain others. The technical phases are handled by the Division of Forestry of the University, while the tests are carried out in coöperation with farm advisors, farm bureaus, and progressive stockmen. Fortunately a very practical application of what is termed the "deferred" system of grazing has been followed for several years by a Shasta County stockman. Deferred grazing provides for so cropping the pasture as to make possible the development at certain intervals of a seed crop of the more valuable forage plants, but in the same season permitting the forage to be utilized. The increased grazing capacity obtained by the stockman mentioned is strikingly shown by the illustrations here reproduced (figs. 70, 71, and 72).

Fig. 71.—A dense, thrifty stand as seen on March 13, 1923, consisting of native grasses, bur clover, and alfilaria of an average height of six inches. During the revegetational period, the range was grazed closely until early in March, after which time no cropping was allowed until the seed had matured. Following the first year of "deferred" grazing, the ranchowner was able to support in good condition more stock than formerly.

The views here shown are only sixty feet apart and were obtained on areas of the same soil type and of similar exposure. The contrast shown is typical of what may be expected where a rational grazing plan is adopted, based upon the growth and life history requirements of the vegetation, as compared with no system at all. A plot has been established on each area here shown, and the forage will be harvested at maturity, the object being to ascertain what difference there may be in the forage yield where the deferred system is used, as compared with that where other grazing methods are used.

One of the most important preliminary phases of the study as a basis for the application of the deferred and rotation grazing system is that of ascertaining the latest date in the spring at which it may be possible to graze an area and yet procure a seed crop. For this purpose three series of three plots

each were established in various parts of Shasta County in accordance with the following schedule:

Series	Dates when plots were fenced		
A	Mar. 5	Mar. 20	Apr. 4
B	Mar. 10	Mar. 25	Apr. 9
C	Mar. 15	Mar. 30	Apr. 14

Observations have shown that vegetation consisting of annual plants may be expected in late spring under normal temperature and soil conditions to complete its cycle of growth in from forty to fifty days after seed germination. Since the growing season in the California foothills ordinarily continues until approximately June 1, it may be possible under good conditions of growth, to procure a seed crop if the grazing is discontinued as late as April 15. According to present observations, however, it is not safe to expect the development of a seed crop of high viability where grazing is continued later than approximately March 20.

Fig. 72.—The protected plot (on the left) representing a foothill pasture grazed throughout the growing season each year yielded one-half ton of ''weedy'' vegetation. The plot (on the right) typifying an area which by proper control of the stock was permitted to develop a seed crop each season for several years, yielded 1.53 tons of forage of high quailty. Cattle grazed on the good pasture were marketed ''grass fat'' in March, 1923, and brought nine cents a pound in Portland, Oregon.

In pasture-forage studies it is very valuable to know what species under undisturbed conditions, as for example, when grazing is discontinued, may gain dominion and constitute the ''climax'' plants. Such facts will show the ideal towards which one may work. To procure these data, eleven fenced plots have been established in Shasta County alone. Since it is not the plan to propose closing depleted ranges to grazing during the period required for the re-establishment of the forage cover, unprotected plots, carefully charted, and corresponding in number to the protected or fenced areas, have been located near the latter. The unprotected plots, which will be grazed normally each year, will be observed closely as to the changes in the vegetation that takes place as a result of different systems of livestock handling and grazing.

GENETICS

Crepis Investigations—Excellent progress has been made during the year on the Adams Fund Project No. 551 which includes the genetic analysis of certain species of *Crepis*, experiments with species hybrids, cytological investigation of all the *Crepis* species and species hybrids obtainable, together with a study of the genus as a whole from a taxonomic point of view.

Collection of Species and Taxonomic Studies.—Approximately one-third of all the species of *Crepis* thus far reported have been accumulated by E. B. Babcock, who is growing and studying them in the greenhouse and garden. Grateful acknowledgment is made of the coöperation and assistance of many correspondents throughout the world from whom it is hoped additional species will be received in the future.

The taxonomic work on *Crepis* has been broadened during the year by using as a reference the treatment of *Crepis* found in Engler and Prantl (Hoffman), *Pflanzenfamilien*, IV: 5 (1891). In this treatment the genus includes eleven sections. We have one or more representative species of each of these except the monotypic sections *Ceramiocephalum patula* Poir., of Algeria, which we are especially anxious to obtain. An investigation of Hoffman's treatment in relation to genetic relations established by hybridization experiments and to the chromosome content of the various species is under way.

Genetic Studies in Crepis capillaris.—Additional studies of inheritance in *Crepis capillaris*[*] have shown the presence of four sets of duplicate genes conditioning the expression of four different characters. The type of linkage for two of the four sets has been determined. Three pairs of complementary genes are also indicated by the records of the past year. Lethal and non-lethal and dominant and recessive genes for reduction of chlorophyll have been demonstrated by J. L. Collins and Miss H. F. Carlyle. It has been shown by Mrs. B. S. Herman that size differences in achenes are hereditary.

Species Hybrids.—The F_2 and sesquihybrid plants of the cross *C. setosa* (N = 4) x *C. biennis* (N = 20) described in our previous report[†] have been grown by J. L. Collins. The backcross to the *setosa* parent produced two general types of plants, (*a*) those similar to the F_1 and (*b*) those which resemble in many characters the *setosa* parent. In the F_2 a remarkable array of plant forms appeared. These forms may be roughly grouped in four classes, viz., 1. *biennis*-like, 2. *setosa*-like, 3. curly-leaved, and 4. linear-leaved (see fig. 73). From the behavior of the chromosomes, as noted in the previous report, it appears that these F_2 forms are due to the variation in the number of *setosa* chromosomes, which may range from 0 to 8. Each of the F_2 plants should have 20 *biennis* chromosomes, which is the haploid number for that species. The following new species crosses have been made by Collins during the year, and F_1 plants are now growing:

C. setosa Hall. (N = 4) x *C. capillaris* (L.) Wallr. (N = 3)
C. setosa Hall. (N = 4) x *C. aspera* L. (N = 4).
C. setosa Hall. (N = 4) x *C. tectorum* L. (N = 4).
C. setosa Hall. (N = 4) x *C. Dioscoridis* L. (N = 4).

---

[*] Report of the College of Agriculture and Agricultural Experiment Station University of California, 1921–22, p. 99.

[†] *Ibid.*, pp. 97–98.

The first of these is a repetition of a previous cross. Although the pollen parent of each of the other three hybrids also has four in the haploid, yet the individuality is very different from that of *setosa*, especially in *Dioscoridis* which has large chromosomes.

Cytological Investigations.—Cytological study of the species hybrids of *Crepis* has been continued by M. C. Mann. Backcrosses of the F_1 from *C. setosa* Hall. (4) x *C. capillaris* (L.) Wallr. (3) on setosa had respectively 7, 8, and 10 chromosomes, showing that as a result of the irregular meiosis of the F_1, viable gametes were produced with 3, 4, and 6 chromosomes. Thus no viable gamete has less than 3 chromosomes. One of the backcross plants was identical with *setosa* in external characters and had a typical *setosa* chromosome group. Since in this plant the chromosomes paired normally at reduction, there can be no doubt that one of the F_1 gametes contained all of the *setosa* and none of the *capillaris* elements. The 7-chromosome plant resembled the F_1, but those with 10 chromosomes are unlike the F_1 or either parent. Especial interest attaches to these since it is hoped that they may be inbred and that from them new stable types may be derived which will throw light upon the method of origin of the wide difference in chromosome number within the genus and upon the effects of a pair of foreign chromosomes in a *setosa* complex.

The work on the hybrid *C. setosa* (4) x *C. biennis* (20) has proved very interesting cyto-genetically. J. L. Collins has succeeded in obtaining F_2 and backcross generations to both parents. Chromosome counts of these have corroborated the observation that in the F_1 hybrid the *biennis chromosomes mate with one another* forming ten pairs, while the four from *setosa* are distributed irregularly. Each of the two F_2 plants which have been counted has 25 chromosomes, the two backcrosses to *setosa*, 17 and 18 respectively, while the backcross to *biennis* has 32. Reduction is nearly normal in all three cases. In the backcross to *biennis* (32 chromosomes) there are about 15 pairs, and lagging chromosomes are very infrequent. That stable races with numbers near to 15, 20, and 30 will be established seems certain. This then is a further demonstration of the fact that races differing greatly in chromosome number may result from species-hybridization, but it is to be noted that the method by which this is accomplished is quite different in these two species hybrids. The evidence from pairing at reduction also indicates that the *biennis* 2N group consists of four sets of duplicate chromosomes sufficiently similar to permit mating, and that it may therefore be considered an octaploid species. The work on cytology in relation to taxonomic position has also led to groupings of species on the basis of cytological similarity. These groupings are of great interest both from the standpoint of relationship within the genus and as a guide to further work on species-hybridization.

Several additional species have been studied: *C. ampexifolia* (2N = 8), *C. blattarioides* (2N = 8), *C. bulbosa* (2N = 18), *C. grandiflora* (2N = 8), *C. montana* (2N = 10), and *C. myriocephala* (2N = 8). It appears that cytologically *C. setosa* and *C. parviflora* are very similar, both as to number and individuality of chromosomes, as are likewise *C. bursifolia, amplexifolia, taraxacifolia, aspera,* and *tectorum*. *Alpina, foetida,* and *rubra* are much alike, while *grandiflora, dioscoridis,* and *pulchra* form another group. It has been shown that cross division of one chromosome of a 3-chromosome species might possibly account for the origin of *C. neglecta* but that all of the other species have greater average total length of chromosomes, and that therefore they could not have

arisen by this method from such a species as *capillaris*. Similarity of chromosome form and shape are not necessarily good guides as to the development and breeding capacity of the hybrid. However, it seems probable that cytological similarity may be one index of relationship and that, given both sets of data—that from species hybridization and that from cytology— we may come to know the genus *Crepis* more thoroughly than any plant genus is now known.

Fig. 73.—Four types of F_2 seedlings from the cross (*Crepis setosa* × *C. biennis*; the lower left specimen (23.312P_{2}) is biennis-like; upper right, setosa-like; upper left, curly leaved; lower right, linear leaved. Several other distinct types occur. The chromosome groups of these types are being studied.

Nematode Investigations.—W. S. Malloch found sixty-eight varieties of cantaloupes to be susceptible to nematode attack. Eight of these varieties were obtained from two sources and two varieties from three sources. Twenty-one selections of Pollock 10–25 all proved to be susceptible.

Ninety-seven varieties of tomatoes were found to be susceptible to nematode attack. Fifteen of these varieties were obtained from two sources, six varieties from three sources, one variety from four sources, and one variety from fourteen sources.

New Era, Blackeye, Whippoorwill, Iron, and Brabham cowpeas were all attacked by nematodes.

The following species of plants were found to be attacked by nematodes.

Lotus corniculatus.
Medicago hispida reticulata.
Phaseolus max (Mung bean).
Pisum sativum.
Sesbania (Macrocarpa?).
Soja max (Virginia, Ito San, and Mammoth Yellow Soybeans).
Stizolobium deeringianum (Velvet bean).
Trifolium alexandrinum.
Trifolium alexandrinum muscowi.
Trifolium alexandrinum Saida.
Trignonella foenum graceum.
Vicia agritinense.
Vicia biennis.
Vicia dasycarpa.
Vicia faba.
Vicia fulgens.
Vicia hybrida.
Vicia ludoviciana.
Vicia pannonica.
Vicia peregrina.
Vicia polyphylla.
Vicia sativa.
Vicia sativa dura.
Vicia sativa leucosperma.
Vicia stricta.
Vicia villosa.

Test of Deciduous Fruit Cuttings.—Deciduous fruit cuttings were planted in beds in a fairly open greenhouse soil with the object of determining how many would root. The following species formed callus and roots: *Cydonia oblonga; Prunus Besseyi, P. pumila, P. bokhariensis, P. cerasifera, P. fremontii* hybrid, *P. mariana, P. mexicana, P. munsoniana, P. spinosa*, one unknown species of *Prunus* called Discovery plum; *Pyrus serotina, P. sinensis*. The following species formed callus only: *Chaenomeles cathagensis; Prunus Fenzliana, P. dasycarpa, P. hybrida, P. Lycioides*, nine unknown species of *Prunus; Pyrus amygdaliformis, P. betulaefolia, P. calleryana P. nivalis, P. phaeocarpa, P. salicifolia, P. ussuriensis*, four unknown species of pears; (*Pyrus baccata* x *P. malus* var. *sylvestris*), *P. purpurea floribunda, P. Sieboldi arborescens, P. Zumi*, nineteen unknown species of apples.

* Previously reported by E. A. Bessey.

The following results were secured with commercial forms: The varieties of *Ficus carica* which rooted are P.L.H. 6243, De l'Archipel, Hamari, Masin No. 20, Oeil de Perdrix, Reculver, Warren's Brown Turkey Xehba. De Constantine formed a callus only. Five U.S.D.A. plant introductions of *Prunus communis* formed a callus. Twelve U.S.D.A. plant introductions of *Prunus persica* formed a callus. One hybrid peach, F_2 Strawberry x Peento, formed roots, and another, Family Favorite x Kalamazoo, formed a callus only. Six U.S.D.A. plant introductions of *Prunus persica nucipersica* formed callus only, and another formed roots. Six U.S.D.A. plant introductions of *Prunus Armeniaca* produced callus. The following forms of *Prunus domestica* produced roots; S.P.I. No. 34268, Clyman, Peach, Pond, Sultan. The other forms of *Prunus domestica* produced callus as follows: P.D. stock of Tribble Bros., S.P.I. Nos. 30690, 53221, 30692, Columbia, Italian Prune, Agen (French), Grand Duke, Imperial Epineuse, Sergeant, Standard, Sugar, Tragedy, Yellow Egg. The following forms of *Prunus salicina* produced roots: Satsuma, Combination, Rutlands plumcot; while Abundance, Santa Rosa, Wickson, and Climax formed callus only. The varieties of *Pyrus communis* which formed callus are as follows: S.P.I. Nos. 32736, 32739, 32746, Favorita, Anjou, Bartlett, Bloodgood, B. S. Fox, Clairgeau, Clapp's Favorite, Col. Wilder, Colorado Seedless, Comet, Comice Danas Hovey, Doyenne, d'Alencon, Doyenne d'été, Easter Beurre, Flemish Beauty, Forelle, Gifford, Glout Morceau, Hardy, Howell, Kieffer, P. Barry, Seckel, Surprise, Winter Nelis. A number of varieties of *Pyrus malus* formed callus as follows: Chanago, Cliff's Seedling, Diadem, Early Harvest, Gen. Carrington, Gravenstein, John Sharp, Keswick Codlin, Maiden Blush, Red Astrachan, Red June, Red Spy, Summer Pearmain, White Astrachan, Yellow Transparent, and three U.S.D.A. plant introductons of *Pyrus malus* var. *sylvestris*. The greenhouse soil in which these cuttings were planted was infested with nematodes but so few of the cuttings had rooted when the experiment was terminated that no notes on nematode infestation were taken.

The results reported above should not be taken as final evidence concerning the possibility of rooting cuttings of the species reported upon. The conditions of planting were fairly uniform, and all of the cuttings were of dormant hard wood, but they came from various sources and, before reaching us, had been handled in different ways. Hence it should not be inferred, because a certain species is listed above as failing to form roots, that this species might not form roots readily if treated differently.

IRRIGATION INVESTIGATIONS

Coöperative Relationships.—A portion of both the investigative and public service activities of the Division of Irrigation Investigations and Practice has been conducted as heretofore in coöperation with the Division of Agricultural Engineering of the United States Department of Agriculture and the Division of Engineering and Irrigation of the State Department of Public Works. Both of these agencies have contributed generously to joint studies of soil moisture and deciduous orchard irrigation, as well as to the alfalfa duty of water studies at the coöperative experimental tract at the Delhi State Land Settlement colony. The Division of Pomology of the College of Agriculture has rendered financial assistance in the work of soil moisture and deciduous orchard irrigation, and A. H. Hendrickson of that division joined with F. J. Veihmeyer in the conduct of these studies. Miscellaneous activities under coöperation with the Federal and State agencies named have included the following: (*a*) Assistance to the State Engineer by F. Adams in connection with irrigation legislation and the organization or development of irrigation districts in Potter Valley, Mendocino County; near Roseville, Sacramento County; at Hollister, San Benito County; at Bishop, Inyo County; at Hemet, Riverside County; and near Vista, San Diego County. (*b*) Assistance to the Associate Chief, Division of Agricultural Engineering, U.S. Department of Agriculture, by S. H. Beckett, H. A. Wadsworth, and Frank Davis, in the collection of information relating to the cost of developing irrigated farms, and by C. N. Johnston in the collection of data relating to the cost of water supplied by private irrigation pumping plants. (*c*) Assistance by F. Adams in planning investigations of seepage losses in irrigation and of economic means of their prevention, as well as general administrative assistance in carrying out coöperative irrigation investigations in California.

Rice Investigations.—Results of rice experiments at the temporary rice experiment station at Cortena, and of collateral chemical and soil examinations by P. L. Hibbard and C. F. Shaw, respectively, during 1922 were published in February, 1923, as Bulletin No. 354 by Carroll F. Dunshee, rice specialist in immediate charge. These showed a very gratifying control of water grass through all-season submergence of the rice to depths of approximately six to eight inches. The 1922 schedule of treatments at Cortena* is being repeated in 1923 with only slight modifications, but with the addition of control studies in tanks and of an experimental row planting of crops recommended by W. W. Mackie and G. W. Hendry as likely to be suitable for "follow" crops after rice. In the control studies in tanks, an effort is being made to determine how much of the water applied to a rice field is lost through percolation from the fields, how much is lost by direct evaporation from the water surface in the flooded checks, and how much is transpired by the rice plants. In these studies a new type of tank made of concrete pipe is being tried in lieu of the usual galvanized iron tanks. In the experimental row planting of "follow" crops, the tests include University Farm Dwarf Milo, Spur Feterita, White Yolo,

* Report of the College of Agriculture and Agricultural Experiment Station, University of California, 1921–22, p. 16.

Hegari, Early Amber, and Honey sorghums; Sudan, Harding, and San Diego grass; Canadian field peas; Red Ripper, Whippoorwill, and Brabham cowpeas, and Mung beans.

As a further collateral feature of the rice investigations, P. L. Hibbard, of the Division of Plant Nutrition, has made chemical examinations of soils from rice fields and from adjacent fields, fallow in 1922, but in rice the four preceding seasons. Soil samples for these studies were taken for the upper eight inches and for a depth of from nine to sixteen inches. Results are reported under Plant Nutrition.* On the whole, this study showed that there is little to indicate that the soil has been permanently injured by rice culture. Furthermore, there seemed to be no very great differences between the fallow soils and the soils in rice in 1922 as regards microörganisms.

Further studies along this line are considered necessary for final conclusions.

Fig. 74.—Irrigating a field of alfalfa at the Delhi State Land Settlement Colony. Part of a study to determine the proper net duty of water being conducted by the Division of Irrigation Investigations and Practice in coöperation with the Division of Agricultural Engineering, U. S. Department of Agriculture, and the Division of Engineering and Irrigation, State Department of Public Works.

Alfalfa Irrigation at Delhi.—Differential irrigation treatments of the alfalfa plots at the coöperative irrigation experimental tract at Delhi were begun by the Division of Irrigation Investigations and Practice in 1923 with two objects in view: (*a*) to determine the seasonal depth of water that will yield the greatest tonnage under Delhi soil conditions; and (*b*) to determine the best unit applications of water with a seasonal application of 36 inches, this having

* See report of Division of Plant Nutrition, p. 169.

been assumed as approximating the most economical application for this locality. A depth of 42 inches produced the largest yield, 9.75 tons to the acre, in 1922, the tonnage increasing slightly for each additional 6 inches up to that point, and falling off slightly for each 6 inches below 42 inches. Under the second phase of the experiments six applications of water of 6 inches in depth each produced the most hay, 7.90 tons to the acre, although the yields with unit applications of 3, 4, and 12 inches in depth were less than one ton to the acre under that.

The Delhi soil is classed as Oakley sand. It has, however, on the experimental tract a compacted and partly cemented layer from about five to about six feet below the surface and averaging about ten inches in thickness. This fact should

Fig. 75.—Irrigating field crops on the University Farm, Davis. An effort is being made to obtain new basic information about the irrigation requirements of certain field crops now widely grown in the interior valleys. The crops included during the past year have been honey sorghum, dwarf milo, Sudan grass, cow peas, and Indian corn.

be considered in interpreting the yields presented, especially the yields under seasonal applications in excess of 42 inches. Soil borings in two checks in the flatter plots receiving unit applications of 8 and 10 inches in depth and seasonal applications of 48 and 60 inches, respectively, disclosed some soil saturation immediately above the compacted layer. In interpreting the yields with the lower seasonal applications, it should be noted that during 1921, the first year of the alfalfa planting, all plots were irrigated uniformly with the object of establishing, as nearly as possible, equal stands before starting differential treatments.

These alfalfa studies have been carried out locally by Martin R. Huberty and Frank Davis according to plans made by the staff of the division. They

are designed to extend over a period of at least five years before definite conclusions and recommendations are attempted.

Irrigation of Field Crops, Davis.—Field crop tests at Davis conducted by S. H. Beckett, H. A. Wadsworth, and Frank Davis during the season of 1922 give additional information[3] regarding the irrigation of Sudan grass, dwarf milo, cowpeas, Indian corn, honey sorghum, and hemp. Although these tests were merely preliminary to more precise tests being arranged for Field No. 2 on the University Farm, the results give a general basis for determining desirable irrigation practice for such crops. The largest yields and the most favorable irrigation treatments in 1922 were as follows: Sudan grass, 8.07 tons to the acre with four irrigations aggregating 13.53 inches in depth; dwarf milo,

Fig. 76.—The effect of late-season irrigation of deciduous fruit trees on dormancy and winter injury is being studied by the Division of Irrigation Investigations and Practice in coöperation with the Division of Pomology. Wilting of the young prune tree on the left resulted from withholding irrigation in the late summer and fall. The trees in the center went into normal dormancy in November in spite of ample soil moisture. The tree on the right wilted early in October with soil moisture about at the wilting point.

2.87 tons of grain to the acre with four irrigations aggregating 13.55 inches in depth; cowpeas, 1,115 pounds of peas to the acre with three irrigations aggregating 16.63 inches in depth; Indian corn, 8.85 tons of ensilage to the acre with three irrigations aggregating 11.31 inches in depth; honey sorghum, 28.17 tons of ensilage to the acre with four irrigations aggregating 17.14 inches in depth. Hemp responded very definitely to thorough irrigation, but results cannot yet be presented, on account of delayed processing of the crop.

[3] Report of the College of Agriculture and Agricultural Experiment Station, University of California, 1921–22, p. 17.

Differential Irrigation Experiments with French Prunes at Davis and Muir Peaches at Delhi.—Differential irrigation treatments were begun by F. J. Veihmeyer and A. H. Hendrickson in 1923 on three acres of French prunes planted at Davis in 1916 and on ten acres of Muir peaches planted at Delhi in 1921. Treatments at Davis are in duplicate and at Delhi are in triplicate, ten five-tree plots being available in the experimental prune orchard at Davis and twenty-three plots, most of eight trees each, being available in the experimental Muir peach orchard at Delhi. The treatments under way are as follows:

French prunes.—(1) Sufficient irrigation of plot I to keep the upper six feet of soil above the wilting point throughout the growing season, except when necessarily rather dry during harvest; (2) the upper six feet of plot II to be

Fig. 77.—Equipment for controlled study of the irrigation of deciduous orchards. This equipment was moved during the year from Mountain View to Davis, where this type of work will now be centered.

kept continuously moist until July 1, and then no further irrigation; (3) irrigation of plot III only from July 1 to harvesting; (4) check plots to be unirrigated except when necessary to have upper six feet of soil well moistened at the beginning of the growing season in the spring.

Muir peaches.—(1) Frequent irrigations to plot I to keep the soil moisture above the wilting point to six feet in depth throughout the season and up to normal dormancy; (2) moderate irrigation to plot II with depletion of soil moisture below the wilting point for periods of at least several weeks; (3) minimum irrigation to plot IV throughout the season without bringing serious injury to the trees; (4) heavy irrigation to plot V until the fruit begins to ripen and then after harvest irrigation only sufficient to prevent permanent injury; (5) minimum irrigation (same as "3") to plot VI until after harvest, but with the soil moisture kept well above the wilting point after harvest and

until the end of the growing season; (6) same as "1" to plot VII but with additional irrigation in January or February; (7) same as "3" to plot VIII but with irrigation in January or February; (8) minimum irrigation to plot IX until fruit begins to ripen and then heavy irrigation.

Transpiration Studies with Prunes.—Studies by F. J. Veihmeyer and A. H. Hendrickson of the use of water by young prune trees grown in potometers under controlled conditions seem to indicate that the rate of the use of soil moisture through transpiration is not materially influenced by the amount of moisture present, provided the moisture present is not below the wilting point. A statement of the close correlation between water loss to leaf area and new length growth is given under Pomology (p. 206). Further observations of a

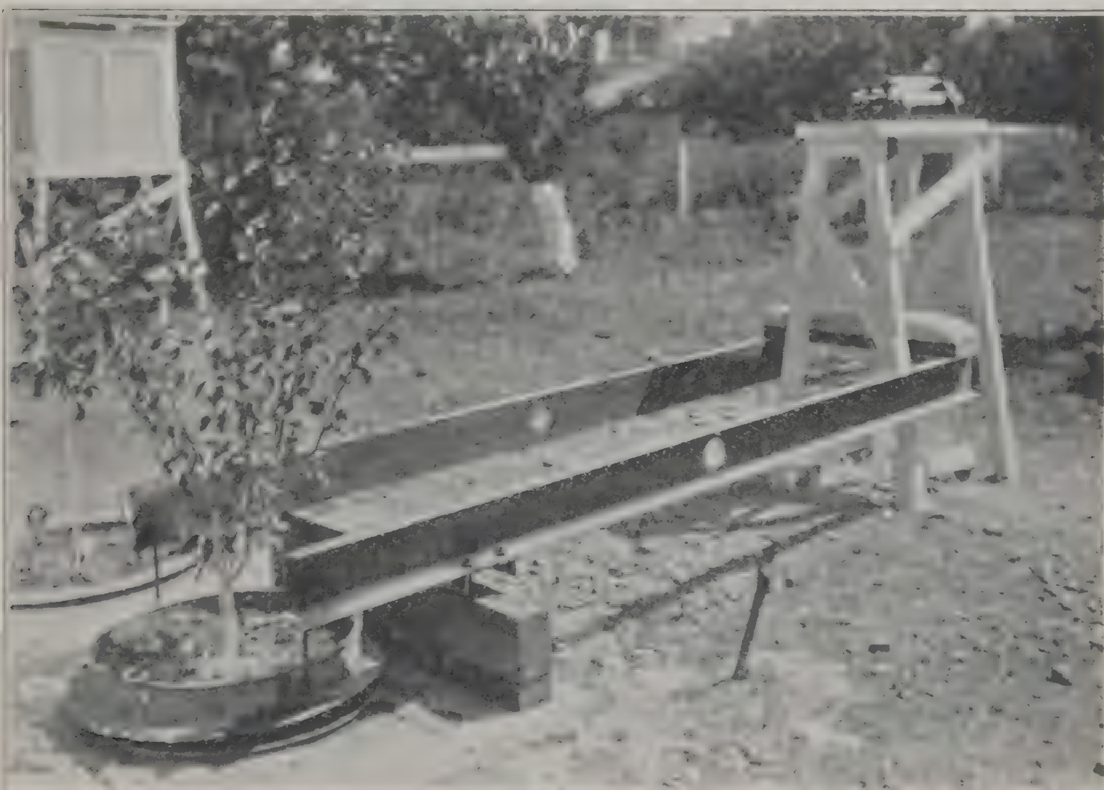


Fig. 78.—The device shown, designed by the Division of Irrigation Investigations and Practice, is automatically measuring the transpiration of water by the young prune tree growing in the potometer. This registering mechanism, built by E. J. Hoff of the Division of Agricultural Engineering, U. S. Department of Agriculture, provides a continuous day and night record of the loss. It is sensitive to losses as low as four ounces in a potometer containing 1000 pounds of soil.

tree automatically balanced* so that losses of moisture as small as four ounces are recorded, substantiate the above statements. On days having comparable climatic conditions, the loss of moisture was the same. In some instances the use of water was greater before irrigation when the moisture in the soil in contact with the roots of the tree was at the wilting coefficient than the day following irrigation when the entire soil mass was raised to its full moisture holding capacity. These results are apparently not in harmony with measure

* Report of the College of Agriculture and Agricultural Experiment Station, University of California, 1920–21, p. [illegible]

ments of transpiration by the cobalt paper method, and additional studies are necessary to reach final conclusions.

Soil Moisture and Dormancy of Prune Trees.—Attempts by A. H. Hendrickson and F. J. Veihmeyer at Mountain View to prolong tree growth by maintaining high moisture content in the soil in tanks with growing prune trees were apparently unsuccessful. Defoliation could be readily brought about by withholding water with consequent wilting of the leaves. Dormancy without wilting did not seem to be influenced by the moisture content of the soil in which the trees were growing.

Fig. 79.—In studies of the waterholding capacities of orchard soils, special basins like the one shown are thrown up in the orchards and irrigated to full field capacity before sampling for moisture.

Movement of Soil Moisture.—Studies of the movement of moisture from moist soil to dry soils were made by F. J. Veihmeyer at Mountain View. A series of metal lined wooden columns 64 inches in cross sectional area and 6 feet in length were packed with carefully screened and mixed clay loam soil. After the packing, the face of the soil column was tightly clamped with plate glass. In one series of experiments the middle sections were packed with soil up to their full field capacity, and the upper and lower sections were packed with soil containing varying degrees of moisture. In another experiment the upper half of the column was packed with soil fully moistened, and the lower half with soil whose moisture content was slightly above the wilting coefficient. The maximum movement either upward or downward from the moist soil into the drier soil as measured by the change of color in the drier soil, this change being visible through the glass, was less than seven inches during a period of four and one-half months.

Moisture Equivalent Studies.—Further studies by F. J. Veihmeyer on the accuracy of moisture equivalent determinations indicate the extreme care necessary to obtain a definite quantity of soil in the centrifuge boxes. As was stated last year,* it is thought that comparable results con be obtained only by carefully weighing the samples placed in the centrifuge boxes. The tests indicate that results are influenced materially by the thickness of the soil layer in the centrifuge boxes, this thickness being determined by the quantity of the soil used as a sample and the evenness with which it is spread over the bottom of the boxes. The same moisture equivalent is obtained with a 15-gram sample occupying one-half of the bottom of the centrifuge box as with a 30-gram sample occupying the entire bottom of the box.

Irrigation Bibliography.—Miss Reid Venable, office assistant, Division of Irrigation Investigations and Practice, during the year completed a selected list of public and semi-public documents dealing with irrigation, soil moisture, duty of water, water supply, and related subjects in California, this list now being in press as Circular No. 260 of the College of Agriculture.

Exchange with Utah Agricultural College.—During June S. H. Beckett of the Division of Irrigation Investigations and Practice gave a short course in irrigation practice in the summer session of the Utah Agricultural College at Logan, Utah, that institution detailing Professor O. W. Israelsen, head of their Division of Irrigation and Drainage, for a like period for conference in connection with studies of the irrigation aspects of soil moisture in California.

Measurement of Irrigation Water.—H. A. Wadsworth of the Division of Irrigation Investigations and Practice has carried on special studies of the adjustable submerged orifice in order to determine the practical limits within which this device can properly be used in the measurement of irrigation water. These studies involve, among other matters, a critical theoretical study of the application to this device of the basic formula $Q = AC\sqrt{2gh}$, with special reference to the exponential value of "*h*." Because of the general use of this device in irrigation, and in order to bring to its study the experience and knowledge of practicing engineers, a research committee for this project has been organized, consisting of Dr. Samuel Fortier, and Major O. P. V. Stout. Work on the project has been done at the experimental field laboratory of measuring devices at Davis and also, through the coöperation of Dr. Samuel Fortier, at the hydraulic laboratory of the Division of Agricultural Engineering, United States Department of Agriculture, and the Colorado Agricultural College at Fort Collins, Colorado.

Removal of Headquarters of Division of Irrigation Investigations and Practice.—In order to bring about more complete correlation between the activities of the Division of Irrigation Investigations and Practice, headquarters of the division, heretofore at Berkeley, were in February, 1923, transferred to the temporary Soils and Irrigation Building at Davis. Coincident with this transfer, the studies in soil moisture and deciduous orchard irrigation, centering during the last two years at the Deciduous Fruit Station at Mountain View, were also established at Davis. It is the plan of the division as far as possible to center all equipment for controlled soil moisture studies and related studies of irrigation practice at Davis, the transfer of equipment from Mountain View being the first step in the policy.

* Report of the College of Agriculture and Agricultural Experiment Station, University of California, 1921–22, p. 107.

Orchard Plantings for Irrigation Experiments.—Four experimental plantings of deciduous fruit trees were made during the year by the Division of Irrigation Investigations and Practice and the Division of Pomology for use in irrigation experiments in conjunction with the controlled studies in tanks at Davis. These plantings included six acres of Philip cling peaches, eight acres of standard French prunes, and five acres of Concord walnuts at Davis, and six acres of Calimyrna figs at Delhi. While these orchards will not be available for differential experimental treatment for several years, a three-acre orchard of French prunes planted in 1916 on the irrigation tract at Davis is available for such purpose beginning with the season of 1923, as noted elsewhere.

Fig. 80.—A fruit tree receiving special irrigation for experimental purposes. In irrigation experiments with orchards, definite quantities of water are added to different groups of trees at different periods of their growth.

Increase of Irrigation Equipment at Davis.—According to plans and under the supervision of S. H. Beckett, material additions were made to the general irrigation equipment on the University Farm at Davis. This increased equipment includes two 14-inch wells, each yielding about 900 gallons a minute, and 31,000 lineal feet of concrete pipe. These additions cover 70 acres of orchard, 40 acres of alfalfa and pasture, 30 acres of field crops, 20 acres of vines, and 10 acres of truck crops, and furnish a supplemental supply to 165 acres under gravity water. The new pipe lines are so connected with each other and with the gravity system on the Farm as to give effective and safe control and timely distribution of water, whether from the Farm canals or from the new pumps.

Supervision of Irrigation on the University Farm.—Beginning with the season of 1922, management of all irrigation on the University Farm has been delegated to the Division of Irrigation Investigations and Practice, with S. H.

Beckett in immediate charge. Under this arrangement Beckett is directly responsible for the dates of irrigation, the amounts of water applied, and the compilation of records of seasonal applications and duty of water on all areas under irrigation. In this connection thirty-two test wells have been bored to ground water and sufficiently frequent readings of water levels are made to give a guide to complete control of ground water and the prevention of its rise to the danger point. It is significant that during 1922 under this unified control of irrigation on the University Farm, the ground water level dropped an average of 2.53 feet between June 3 and December 3, and this in spite of the fact that 84 per cent of the irrigation water used is obtained from an outside gravity supply.

Community Irrigation Movements in California.—California is now passing through a transition period in the organization of irrigation enterprises, all looking toward a greater measure of ownership and control of irrigation systems and a reorganization and consolidation of irrigation systems to eliminate water-right conflicts over common sources of irrigation water and to furnish the basic agreements and legal security essential for financing much needed storage. On account of other duties, the Division of Irrigation Investigations and Practice has been unable to participate in other than a general way in these transition movements during the past year. Through frequent conferences with those interested and through visits to as many as possible of the communities concerned, it has, however, undertaken to keep in touch with the more important activities in this field, as, for instance, those relating to the so-called Pine Flat project on King's River; to the organization of the proposed water storage district on San Joaquin River; to the consolidation under an irrigation district of the numerous small mutual water companies taking water from Owens River near Bishop, Inyo County; to the movement to form the Santa Clara County Irrigation District; to the proposed taking over by an irrigation district of the public utility now supplying irrigation water to the community about Hemet, Riverside County; and to the absorption by Imperial Irrigation District of the mutual water companies that up to the spring of 1923 have been controlling the distribution or irrigation water to Imperial Valley. Such movements as these involve many of the larger problems of irrigation management, such as the relative interests of the state, the communities, and the individual water users; the rights of water-contract holders under public utilities after such public utilities are taken over by irrigation or water storage districts; economically justifiable costs of irrigation water; the safe financing of community irrigation enterprises; and the proper balancing of individual and general benefits accruing from the more complete conservation of irrigation water. Aside from assistance to the State Engineer in matters of this nature, already referred to, Frank Adams has made field studies of the conditions presented at Bishop, at Hemet, and in the Imperial Valley, information gathered being reported under Project No. 654.

NUTRITION

Alfalfa Hay.—Samples of four cuttings of alfalfa hay grown in Owens Valley in 1922 were submitted by County Agent J. P. Hertel with the request that a report be made covering the comparative value of the respective cuttings. The analytical data show that, with the exception of the second cutting, the hays were of high quality if measured on the basis of their protein content, and it would appear that this is a proper method of comparison. Analyses indicate that the third and fourth cuttings had practically the same chemical value.

	4088 1st cutting per cent	4088*a* 2nd cutting per cent	4088*b* 3rd cutting per cent	4088*c* 4th cutting per cent
Moisture	9.47	8.99	8.86	8.67
Protein	16.96	13.43	17.69	17.29
Fat	1.83	2.16	3.26	2.33
Ash	10.48	7.99	10.20	9.57
Crude Fiber	26.49	31.62	23.15	24.13
N-Free Extract	34.77	35.81	36.84	38.01
Totals	100.00	100.00	100.00	100.00

The fertilizing value of the first cutting was superior to that of the second, in that the protein and ash percentages are both higher, being 16.96 and 10.48 per cent, respectively, for the first cutting and 13.43 and 7.99 per cent for the second. In this connection it might be said there is little choice between the fertilizing values of first, third, and fourth cuttings. While the protein percentages of the third and fourth cuttings, 17.69 and 17.29 per cent, respectively, were far higher than the average noted for alfalfa hay, they are below the figure 18.27 per cent reported for protein of first and second cuttings of alfalfa hay from Lancaster.

Copper Content of Apricots.—B. A. Rudolph, Research Associate in Plant Pathology, Mountain View Station, submitted samples of apricots which had been sprayed with Bordeaux mixture a short time before picking and canning. Analysis of the fruit was requested for the purpose of ascertaining whether the amount of copper retained was injurious to health. A chemical examination showed the presence of copper to the extent of 1.08 parts to the million, an amount less than is found in the oyster. Many food materials of plant origin are reported by Dr. B. Guerithault* to have copper in amounts varying from 8.7 to 63.6 milligrams per 100 grams of the ash, corresponding to 1.1 to 17.1 parts per million of the fresh material. It appears therefore that if the sample of apricot submitted was representative, no injurious results would follow the consumption of such apricots by the average healthy normal individual.

Bran Products.—Four samples of bran products, including biscuits and parched bran, were studied by M. E. Jaffa and H. Goss with the result that the protein content was found to vary from a minimum of 14.41 per cent to

* Experiment Station Record, vol. 44, no. 1, p. 62.

a maximum of 19 per cent. It must be remembered in this connection that in accordance with work done by the Bureau of Chemistry, U. S. Department of Agriculture, the digestion coefficient for the carbohydrates in bran is less than 60 per cent; for protein it varies from 25 to 45 per cent. It is therefore seen that the assimilation of the chief nutrients in bran is low. It is true that bran contains certain minerals which are valuable, but that there is *not* an adequate supply for the growing animal.

With reference to vitamins, it should be said that bran contains but little vitamin "A" and no vitamin "C" and is much poorer in vitamin "B" than the wheat germ.

The digestion coefficient for protein in white bread approaches 90 per cent, while that for the carbohydrates is between 96 and 97.

There is no doubt whatever that bran products have a value as a medicine or a tonic, since they are laxative, but that the nutrients in bran or bran products for man possess low digestion coefficients.

Carob Bean.—A sample of carob bean was received by M. E. Jaffa and H. Goss from Santa Fe Springs with the request for an analysis of its sugar and protein content. A news item had stated that the carob tree at Santa Fe produced a bean containing over 50 per cent of sugar and a much higher percentage of protein than that recorded for any other carob bean which had been tested by the University. The chemical analysis, however, proved the sugar to be 31.19 instead of 51 per cent. The protein in the bean was found to be 5.01 per cent, which is lower than the average, 5.54, for five complete analyses previously reported.* Other analyses made of samples purporting to come from the same tree also confirm these findings. In other words, a carob bean from Santa Fe is not richer than many other beans grown elsewhere.

Cherokee Rose.—Professor Gordon H. True of the Division of Animal Husbandry submitted a sample of stems and leaves from the Cherokee rose, requesting its investigation as a possible forage crop for livestock. It is claimed that the plant is very hardy and exceedingly palatable.

The material as submitted shows 23.4 per cent moisture, which is probably less than the plant would contain when consumed. The content of the respective nutrients clearly indicates that the plant is richer in protein than either wheat or oat hay on the same moisture basis. Furthermore, the crude fiber content is less than that reported for ordinary cereal hays. It would, therefore, appear that the rose has a feeding value fully equal to that of the hays in question.

Copper Carbonate Analyses.—In coöperation with W. W. Mackie and F. N. Briggs in their investigations with dust of basic copper carbonate as a means of controlling seed borne bunt, eight complete analyses of copper carbonate from samples sold in the market were made by H. Goss. An attempt was made to determine, if possible by chemical and physical analyses, why some samples were much more efficient than others.

There was little variation, with one exception, in the amount of copper present (52.2 per cent average), or in the amount of carbonate dioxide (18.2 per cent), or even in the total alkalinity. Most samples corresponded approximately to the formula $CuCO_3$, $Cu(OH)_2$. However, when the relative density or compactness of the powders was measured, a wide variation was found. Those samples which were reported satisfactory for control of bunt varied in

* College of Agriculture and Agricultural Experiment Station, University of California, Bulletin 309, p. 449.

density from 0.45 to 0.82 grams, or an average of 0.63 per cubic centimeter. The unsatisfactory samples averaged over one gram per cubic centimeter and were considerably coarser in texture.

Sugar Content of Dates.—The Valley Packing Association, Coachella, California, forwarded in September, 1922, four samples of dates; namely, Kasbeh, Khadhrawi, Dubaini, and Zahidi.

The analytical data obtained for 1922 agree very well with those obtained for the same varieties for the previous year* except that the average sugar content on a water-free basis, is slightly higher for the past year's crop, as indicated by the following interesting figures:

For 1922, the Khadhrawi represented the maximum in sugar content containing 86.3 per cent and the Zahidi, the minimum, containing 82.2 per cent. For the four samples the average per cent of sugar was found to be 83.9.

Fumigation of Dates.—At the request of the Deglet Noor Date Co., Indio, California, in October, 1922, the Division of Nutrition made experiments to determine the effect of hydrocyanic acid on dates. Dates were fumigated in the Nutrition Laboratory by exposure to the fumes of hydrocyanic gas in a tightly closed dessicator jar. After exposure for one hour air was forced through the jar to drive out the poisonous gas. The dates were removed and bottled. Shortly after the fumigation, the dates showed a large amount of hydrocyanic gas. Three days later the analysis of dates from the same batch still showed an appreciable amount of hydrocyanic gas. Two weeks later an examination of dates from the original fumigated batch showed only traces of hydrocyanic gas. In other words, it appears that if the dates are to be fumigated with hydrocyanic gas, they should not be offered for sale until they have been exposed to the air for at least two weeks after fumigation.

Nutritive Value of Giant Kale Stalks.—Professor James P. Dryden of Concord, submitted to the Nutrition Division a sample of Giant kale stalks for the purpose of ascertaining the nutritive value of the inner part or the ''marrow'' of the stalk. It is claimed that chicks greatly relish the ''marrow'' which is made available by splitting the stalks vertically. The tough part is not eaten.

A chemical analysis shows that the edible portion of the stalk contains practically 90 per cent of water, but even with the high water content, it is rich in mineral matter and protein, since practically 20 per cent of the dry matter consists of protein and mineral matter respectively. In view also of the low content of crude fiber, this edible portion of the kale stalk is well adapted to the feeding of little chicks.

Horse Bean.—Samples of the horse bean from plantings made in December, 1921, February, 1922, and March, 1922, and harvested in June, 1922, were submitted by Mr. Bell of Halfmoon Bay. A physical analysis of the proportion of the leaves, stalks, and pods for the December and February plantings only was made. No corresponding separation was made for the March sample. The percentage of leaf was greater in the February sample, being 35.9 per cent, while the percentage of pod (38.29 per cent) predominates in the December planting. There is not much difference in the feeding value of these samples, since the nutritional worth of the pods and leaves does not differ materially. The advantage, however, is on the side of December planting on account of its

* Report of the College of Agriculture and Agricultural Experiment Station, 1921–22, pp. 110–111.

slightly higher yield of dry matter. The analysis of the entire plant proves that is a valuable feedstuff far richer in protein than the cereal fodders with the same moisture condition, and that it compares most favorably with alfalfa in this respect.

Malva Leaves as Green Food for Poultry.—Samples of malva leaves were submitted to M. E. Jaffa and H. Goss of the Nutrition Laboratory by Charles H. Robinson, Morro, California, with the request for information concerning the value of malva leaves as a green food for poultry. The results of the analysis given below are very encouraging. They show that these leaves with practically 81 per cent moisture and 8.34 per cent protein are far richer than alfalfa:

Moisture, per cent	80.90
Protein, per cent	8.34
Fat, per cent	0.86
Ash, per cent	2.43
Crude Fiber, per cent	1.38
N-Free Extract, per cent	6.09
Total	100.00

Metabolism investigations have not been conducted in connection with these leaves, and therefore, the availability is not accurately known, but it is fair to assume that the digestion coefficients for poultry of the respective nutrients in malva leaves are not appreciably lower than those reported for the alfalfa leaf. Again, the vitamin content of the malva leaf has not been ascertained, while that of the alfalfa leaf is well known. There is no reason for supposing, however, that the malva leaf should be devoid of vitamins, for most of the green foods that have been investigated show appreciable contents of the water-soluble vitamins.

The mineral content is also high, particularly since the 2.43 per cent of ash refers to about 20 per cent dry matter. The proportion, therefore, of the ash in the dry matter is practically 12.5 per cent or one-eighth of the whole. This is a most excellent showing and enhances the value of the malva for poultry. It appears therefore from the foregoing that the malva is excellent as a green food for poultry.

Miscellaneous Analyses.—As a part of the public service work of the Nutrition Division and in order satisfactorily to respond to the requests of a large number of correspondents it has been necessary to examine more or less completely, chemically and microscopically, about 500 samples of miscellaneous products consisting in the main of foods and food products for man and other animals.

Orange By-Porducts as Cattle Food.—The Exchange Orange Products Co., of San Dimas, submitted to M. E. Jaffa and H. Goss samples of orange pulp and orange pulp silage for the purpose of ascertaining whether or not such by-product were valuable for cattle feeding.* It was stated that a large dairy had fed orange pulp with success to their herd for three months during the summer of 1922.

* See report of Division of Animal Husbandry, p. 82.

The material was in sound condition when received, had a pleasant odor, and was very palatable. The composition corresponds more closely to the composition of beet pulp silage than to any other cattle food, the difference being that the beet by-product contains more crude fiber. If the orange pulp and orange pulp silage are relished by the cattle, they should prove of higher value than the beet pulp or beet pulp silage, since the mineral content is more than 50 per cent greater than that noted for beet pulp. Furthermore, orange products contain vitamins which are not found in the beet pulp, and which are essential for the production of the best quality of milk.

Analyses of Range Forage Plants Collected at Shingle Springs.—A further study* by the Division of Nutrition of forage plants collected in October, 1922, at Shingle Springs, Placer County, California, confirms the findings of previous investigations with reference to nutritional value. The protein content was low in each of the eight samples tested, the maximum being 5.71 per cent and the minimum, 3.09 per cent. These low percentages were due to the fact that the samples were practically devoid of seeds. The maximum content of crude fiber, 36.22 per cent, agrees quite well with the average reported for the analyses of 12 samples of rye hay; while the minimum, 28.57 per cent, corresponds practically to the average of crude fiber in alfalfa hay.

Vicia Monanthos Seed, Flowered Vetch or Lentil as a Supplemental Feed for Cattle.—Mr. Albert F. Etter of Humboldt County submitted to M. E. Jaffa and H. Goss a sample of Vicia Monanthos seed, flowered vetch or lentil, in order to ascertain its feed value for dairy cows.

An analysis of the seed shows that it corresponds almost identically with the analysis of the ordinary lentil and that as a source of protein, this vetch is richer than coconut oil cake-meal. The protein content in the latter does not average above 20 per cent while the protein content of this vetch is 25.3 per cent. The seed, therefore, is well adapted for the feeding of cows and as far as protein element of the ration is concerned, can well be substituted for coconut or linseed oil cake-meal.

Vitamin Investigations.—The Nutrition Division has undertaken studies with guinea pigs as subjects to determine the relative content of vitamin ''C'' in certain typical California fruit juices and citrus by-products. Preliminary results indicate that pasteurized strawberry syrup is far superior to either pasteurized loganberry or blackberry syrup in potency of vitamin ''C.'' This is a tentative but extremely interesting conclusion.

Watermelon Pulp and Rind as Supplemental Feed for Livestock.—The Germaine Seed Co., of Los Angeles, submitted to M. E. Jaffa and H. Goss of the Nutrition Laboratory a sample of dried watermelon including pulp and rind. Since the market is more or less glutted with watermelons at times it has been suggested that the dessicated product would afford an excellent means of disposing of the surplus.

Analytical data show that the protein content, 13.17 per cent, of the dried watermelon is higher than that of the ordinary cereal. Whether or not the biological value of the protein is equal to grain has not been determined. The figures for fat and mineral matter are higher than those usually reported for grain; particularly is this true with reference to the ash. In this connection,

* Report of the College of Agriculture and Agricultural Experiment Station, University of California, 1921–22, p. 111.

however, it must be remembered that the crude fiber is fully 10 times as great in the dried watermelon as that reported for wheat or Indian corn. If, however, the melon can be dried and sold at a reasonable price, the product would be worthy of consideration as an ingredient of the ration in feeding animals.

Whale Meat and Bone for Feeding Poultry.—A sample of whale meat and bone was examined by M. E. Jaffa and H. Goss to determine its value as a substitute for beef scrap in poultry rations. The analysis shows the material to contain 39.4 per cent crude protein and 43.15 per cent ash. The ash consists mainly

Fig. 81.—Guinea pig showing symptoms of scurvy on basal diet plus loganberry juice.

of calcium phosphate, indicating that its source is bone. The crude protein corresponds biologically to meat protein, in that the percentage of true protein in the crude compares very favorably with a similar percentage for beef. The material submitted contained only a small percentage of fat, most of this ingredient having been extracted with steam. Whale meat prepared in this manner should be more desirable for poultry feeding than some of the brands of beef scrap, since the protein of the whale meat does not contain undesirable nitrogenous compounds as far as nutrition is concerned. The calcium phosphate in the whale and bone product is also excellent for poultry whether it be the young and growing pullet or the laying hen.

PLANT NUTRITION

Relation of Yield of Wheat to Length of Period of Growth.—A correlation was found, by W. F. Gericke, to exist between the yield of grain and the relative earliness of different varieties of spring wheat when grown in a medium markedly deficient in nutrients. Of ten different varieties of spring wheat, representing a range from very early to very late wheats, the largest yield was produced from the variety maturing first and the lowest yield from that maturing last, the intervening values generally corresponding to the relative earliness of the variety. These results were obtained by growing wheat to maturity in two quarts of tap water. No change other than one addition of approximately 500 cc. of distilled water was made during the test. There was no correlation between the yield of grain and the relative earliness of these ten different varieties when grown in media well supplied with nutrients.

It appears from these results that a factor which bears upon the adaptation of wheat (and perhaps many other plants) for the production of the largest yield of grain from a soil deficient in nutrients, is related to that genetic property which determines how much faster one variety may complete its growth than another. The physiological significance of this is that the soil has a certain quantum of plant food that becomes available in a given period, and the cereal that goes through its growth cycle first, when plant food is limited, is a more efficient user of that limited amount for the production of grain than is a late variety. In this latter case, more will be used in the vegetative processes, and hence less will be available for grain production.

*Continuation of Studies on Factors Influencing Protein Content of Wheat.** Ten different varieties of spring wheat, representing a range from very early to very late wheat, were planted in a soil of a moderate fertility and were treated with sodium nitrate at different stages of growth. These wheats were grown to maturity in pots in the greenhouse, using a soil of moderate fertility. The grain produced was analyzed for nitrogen. The results of these experiments led to the following conclusions:

1. That the magnitude of change in the nitrogen and hence in protein content of early wheat brought about by supplying nitrogen at different times in the period of growth is much smaller than that produced by similar treatments applied to late maturing varieties.

2. The protein content of the very earliest maturing varieties was changed by the treatment from 25 to 50 per cent, while that of the very late varieties was changed more than 100 per cent; that is, the protein content was practically doubled in late spring wheats by supplying nitrogen at the proper growth period. These results show that wheats which are genetically early are physiologically better adapted to produce high protein grain, when they are grown under conditions where the supply of nitrogen available at later stages of growth becomes a limiting factor. The explanation appears to be that only a given amount of nitrogen becomes available in a given time, and the wheat which has a short growing period will use a relatively smaller amount of this total available

* Report of the College of Agriculture and Agricultural Experiment Station, University of California, 1921–22, pp. 115–116.

nitrogen for vegetative growth, leaving relatively more available for the later growing period when grain is formed. The late varieties having a longer growing period must make a greater draft on the nitrogen to maintain their vegetative functions.

3. These results suggest that a very important factor in the improvement of wheat by selection is breeding for earliness, rather than for high protein content *per se*. In other words, the high protein content of early wheat is an effect of the genetic character of earliness.

Composition of Plant Roots in Relation to Alkali Injury.—Practically no information exists concerning the quantitative composition of plant roots, yet this is obviously a question of great interest, especially in connection with the relation between root injury and black alkali soils. M. S. Benjamin, a graduate student, working with D. R. Hoagland and W. H. Dore, has analyzed roots of barley, wheat, pea, and cucumber seedlings grown in tap water or culture solution. Pentoses and starch were absent from all of the roots examined. The hemicelluloses of the barley and wheat roots consist chiefly of pentosans with a small amount of hexosans. Pentosans are absent from the roots of the pea and cucumber and the hemicelluloses consist of hexosans. Much larger amounts of both cellulose and hemicelluloses are found in the barley and wheat than in the pea and cucumber, and this fact, together with the higher pentosan content, may perhaps partly explain the superior resistance of the cereals to alkali injury. It appears probable that the quantity and kind of pectin substance in the root may have some relation to resistance to alkali. Some data were obtained regarding the pectin content of these roots, but owing to the small amount of plant material available, the results are too meager to justify any conclusions.

In extension of the work of M. S. Benjamin, W. H. Dore has analyzed barley and Bermuda grass roots, finding no significant differences between the respective amounts of cellulose, hemicelluloses, and pentosans of these two plants. However, the Bermuda grass roots showed a markedly higher suberin content, and suberization may possibly account for the remarkable resistance of these plants to alkaline salts.

The Interpretation of Culture Solution Data. II. The Influence of the Climatic Complex upon the Duplication of Experiments.—The investigation under this heading, reported last year by A. R. Davis as being in progress,* has been completed. More comprehensive data have substantiated the conclusions tentatively advanced at that time; i.e., that the "growth" efficiency relationship between any two culture solutions may be greatly modified by the various factors making up the climatic complex, and further that such modification may be great enough to prevent the duplication of results. Comparisons of two quite diverse culture solutions (Shive's R_1C_1 and R_5C_2) were made at eight different four-week periods throughout the year. Two hundred and fifty wheat plants were grown in each solution at each period, the mean dry weight of plants being the criterion of comparison, and proper recognition being given to the probable error involved. The frequency curves for these two solutions showed little overlapping during the months of April, June, and August, and the means were significantly distant from each other. As the light and temperature values decreased, however, the frequency curves overlapped more and

* Report of the College of Agriculture and Agricultural Experiment Station, University of California, 1921–22, pp. 114–115.

more until, during the November and December periods, they were approximately merged. As the temperature and light values passed the minimum and began to increase, the means again gradually increased their distance from each other until the maximum departure was registered in June and August. The above facts have a most important bearing upon investigations of any sort seeking to solve problems in plant nutrition, whether such experiments be conducted under field, or under laboratory conditions. They further point to the great need for methods and apparatus by which the several factors of the environment can be isolated and controlled.

Studies of the Growth of Wheat in Combinations of Single Salt Solutions.—W. F. Gericke has carried out systematic experiments to determine the relative physiological importance of the relation of one element to another in the culture media of plants.

The following conclusions were reached:

1. Wheat will grow to maturity when the essential elements are supplied in the form of single salt solutions used in rotation, provided the proper salts are used, and the proper apportionment of exposure of the cultures to the various salt solutions is made.

2. The order of exposure of the cultures to different single salt solutions which together make a complete nutrient solution, has apparently considerable physiological importance. It appears from the results of these experiments, which were comprehensive and included all possible orders of exposures, that the physiological response of the plant to a given salt will be affected by the nature of the salt used in a previous exposure, as indicated in the following statements:

(a) *With initial exposure to potassium salt.*—The highest yield of all types was obtained when magnesium followed the potassium salt, and the lowest yield of all types was obtained when calcium followed the potassium salts.

(b) *With initial exposure to calcium salt.*—The best yields of all types were obtained when potassium salts followed calcium salts, and the lowest yields of all types were obtained when magnesium salts followed calcium salts.

(c) *With initial exposure to magnesium salt.*—The values obtained did not show any clear relationship between growth and the order of exposure; that is, it appeared to be immaterial whether calcium followed potassium, or magnesium followed potassium.

The Effect of Nutrition on the Relative Maturity of Different Varieties of Spring Wheat.—The results obtained from culture solution experiments by W. F. Gericke show that the relative earliness (or lateness) of different varieties of spring wheat is markedly affected by the kind of media in which the plants are rooted. The order of ripening of the different varieties of spring wheat grown to maturity in tap water was markedly different from that which is usually obtained when these varieties are grown in fertile soil. Thus, wheat that is relatively late (comparing one variety with another) under one set of conditions may become relatively early when grown under other conditions. The results obtained from the solution culture experiments show that environmental factors, such as the nutrition of plants, play no inconsiderable part in influencing the development of certain genetic characters used in agronomic descriptions of wheat.

Examination of Soils in Connection with Experiments on Duty of Water (in coöperation with Division of Irrigations' Investigations).—In order to determine the possible effects of impure water on soil plots used in a study of the "Duty of Water for Irrigation," a thorough sampling of one plot was made in November, 1922, by P. L. Hibbard. The 196 samples, representing an area of somewhat less than two acres, were tested by the usual routine methods for determining alkali. The results indicated that the soil of the area sampled is practically uniform as far as salt content is concerned, and contains no notable amount of alkaline or neutral salts. Some variations in physical character were readily noted. It may be inferred that for the purpose of any similar investigation in the future, a much smaller number of samples will adequately represent the soil of a plot of this size in the same locality.

Chemical Studies of Water and Soils in Connection with Rice Investigations.—In order to determine what chemical changes are produced in the waters by use on rice fields and how the alkali in the rice soils is affected by rice culture, samples of water were taken at frequent intervals during the growing season before and after use on the rice fields in several localities, and samples of soils were taken from approximately the same places before planting and after harvest. The results may be summarized as follows:

1. The irrigating water from the Sacramento River is of good quality and varies little throughout the season.

2. Drainage water from rice fields which have been flooded for two or more years, is likely to be of fairly good quality for irrigation, but if the soil contains much alkali within two feet of the surface, some of these soluble substances will be carried off in the drainage water, so that it may sometimes become unsuitable for irrigation.

3. Considering that rice is relatively tolerant of saline water, it seems feasible to use drainage from one field to irrigate the next lower field, and so on until the final drainage become too saline for use. In this way, the duty of water would be increased.

4. There seems to be little percolation of the water down through the clay soils, so that salts in those soils two feet or more below the surface will be removed only very slowly by the flooding practiced in rice culture. In more easily penetrable silts or sand, there is sufficient percolation of the water within a few years to carry away most of the objectionable salts from the region of plant roots into the underdrainage.

5. The original soils at Cortena contain much saline and alkaline matter down to a depth of at least twelve feet. There is great variability in the distribution of this soluble matter throughout the soil.

6. Those soils which have been flooded for three or four years have lost most of the alkali from the upper two feet, though a large amount remains in some places. Below three feet, there is little evidence of change.

7. The results of this year's work do not indicate that the flooding has caused any great change in the amount or location of the salts in the soil at Cortena, except that chlorides originally near the surface have been washed down one or two feet. Below four feet it was not possible to note any change.

8. On the porous soils of Imperial Valley, rice flooding in one season has greatly diminished the alkali in the upper four feet.

9. When alkali soils are flooded, the chlorides are most rapidly removed; sulphates may require two or three times as long as chlorides, and carbonates ten or twenty times as long.

Examination of Well Waters of Sacramento Valley.—P. L. Hibbard, assisted by D. C. Caudron, visited and tested the water from wells throughout the valley in June and July, 1922. Waters from representative wells in all the principal agricultural areas were examined. About 170 different samples were tested. Only a few of these showed the waters to be unfit for irrigation. Most of the waters of poor quality were found in the valley of Putah Creek. The underground water of this region seems likely to contain objectionable amounts of saline and alkaline matter. A few other wells on the west side of the valley were not as good as is desirable, but no region of generally bad water was found, nor were there any very poor waters found on the east side of the river. With few exceptions, all were of excellent quality.

Preliminary Observations on the Question: How to Use Alkali Water with the Least Injury to the Soil.—It was hoped that this preliminary study by P. L. Hibbard would reveal more clearly the principal points which should be investigated, and would suggest suitable methods of procedure to be used in a more elaborate and thorough study of the subject.

The work done consisted in percolating through a silty clay loam soil, seven types of synthetic alkali water, and observing the effects on the soil and on the percolates. The soil was used under three conditions (1) the natural soil, (2) soil plus $CaCO_3$, (3) soil plus $CaCO_3$ and alfalfa meal.

The percolation lasted about three months, during which time as much water as possible was passed through each soil. In some cases, 20 liters were percolated, but with the waters of high pH values, the amount was much less than 20 liters. At the end of the experiment, the soil was allowed to dry without washing out the salts left by the alkali waters, consequently these soils contained more salts than at the beginning, although the increase was comparatively slight. No great physical change was noted in the soils to which NaCl or Na_2SO_4 was added. Sodium carbonate quickly produced marked physical injury to the soil. When $CaCO_3$ was mixed with the soil, it remained in better physical condition. When $CaCO_3$ and alfalfa meal were added, the condition of the soil was still better. Gypsum added to the water containing NaCl or Na_2SO_4 did not seem to produce any decided effect under the conditions of the experiment, but the bad effects of Na_2CO_3 were almost entirely prevented by the addition of gypsum.

With regard to the percolates, NaCl and Na_2SO_4 caused increases in the content of Ca, while Na_2CO_3 had the opposite effect. Calcium carbonate added to the soil caused an increase in the amount of Ca. Alfalfa meal greatly increased the content of Ca in the percolates.

To summarize the results, it appears that saline waters (1000 P. P. M. Cl or SO_4) may be passed through certain soils for some time without causing an accumulation of salts in the soil. Sodium carbonate (500 P. P. M.) may produce bad effects on the soil very quickly. These bad effects may be largely or entirely prevented if gypsum in amounts chemically equivalent to the sodium carbonate be added to the water before applying it to the soil. Presence of $CaCO_3$ and organic matter (alfalfa meal) may still further counteract the evil effects of saline or alkaline waters on soil.

Much more elaborate and extensive experiments under controlled conditions will be necessary to determine accurately the effects of alkaline waters on soils, and to discover how such waters may be used for irrigation without causing serious injury to the soil.

Electric Charge of Clay Colloids.—D. R. Hoagland and W. C. Dayhuff (a graduate student) have studied a highly colloidal clay obtained through the courtesy of C. F. Shaw. This clay was found in the recently dried surface of Lake Rosamund. The rate of migration of the clay particles under the influence of an electric current was determined under conditions of varying concentrations of hydrogen ion and of different concentrations of cations. It appeared that the colloid was changed negatively throughout the whole range of hydrogen ion concentrations studied from pH 2 to pH 12. The intensity of the electric charge was decreased by cations in suitable concentration, bivalent and trivalent cations being most effective. In the case of this clay, no evidence of an isoelectric point was obtained, and the hydrogen ion concentration of the solution seemed to have a significant effect, not mainly *per se*, but because of its influence on the quantity of calcium or other multivalent bases held in solution. These results are of interest in connection with the study of the physical condition of black alkali soils.

The Influence of Plants on the Reaction of Culture Media.—In extension of previous work, D. R. Hoagland and D. C. Caudron have made many observations on the change of hydrogen ion concentration produced in different solutions by the growth of plants of different types. Numerous single salt solutions were used, and it was found that in the case of a number of salts (especially ammonium salts and sulfates) that seedlings brought about an increase of acidity to the extent of pH 3.2. Previous conclusions with regard to complete culture solutions and solutions containing nitrate were confirmed. These generally have their reaction changed to approximate neutrality. The results of these studies on the reaction of solutions have been of value in connection with the general investigation of the mechanism of absorption of inorganic elements by plants.

Fixation of Nitrogen by Wheat Plants.—C. B. Lipman and J. K. Taylor (a graduate student), associated with the work of the Division of Plant Nutrition, have shown that appreciable quantities of atmospheric nitrogen are fixed by wheat plants. This fixation occurs even when air is used which is freed from ammonia. These findings are in complete agreement with the work of Mameli and Pollacci in Italy, but do not support the current teaching that higher plants do not fix nitrogen.

Growth of Plants Under Artificial Light for Experimental Purposes.—A grant from the University of California Board of Research, and the coöperation of J. P. Bennett and the Division of Pomology have made it possible for D. R. Hoagland and A. R. Davis to carry out a series of experiments with the idea of developing means whereby plants may be grown under controlled conditions. These experiments involve the use of artificial light as the sole source of illumination, since it is obviously impossible to control sunlight. After many preliminary trials, an apparatus has been devised which gives promise of evolving ultimately into a chamber in which light and temperature conditions can be varied as desired. It is thought that many problems of plant nutrition can be solved only when each factor can be controlled, and it is especially necessary to study the interrelations existing between the aerial environment and the root environment.

Nitrogen Metabolism of Plants.—One of the most interesting questions of plant metabolism concerns the chemical changes which the nitrate undergoes after its absorption into the plant. This question has been under investigation during the past year by D. R. Hoagland and D. C. Caudron. One of the great difficulties of the work has to do with the chemical methods available for estimating the different kinds of nitrogen present in plant issues. Much attention has been given to a critical examination of analytical methods suitable for this purpose, and a reasonably satisfactory technique has been evolved for the determination of a number of important forms of nitrogen. The results of experiments with barley and peas show that ammonia nitrogen is present only in small concentrations in the juices from stems, leaves, or roots, and is relatively constant in amount. The concentration of nitrate is generally higher in the roots and stems than in the leaves. In the latter, very rapid reduction of nitrate may take place. Preliminary experiments indicate that the concentration of potassium or calcium present in the juices exercises a significant effect upon the reduction of nitrate and upon the formation of complex nitrogenous compounds. Amino acids are usually present in considerable concentration and may be increased or decreased in quantity by various conditions which are subject to control. The further investigation of these questions is very necessary to an understanding of the nitrogen relations of soil and plant. The work also has a definite bearing on the feeding value of crops, as influenced by the stage of growth and by soil conditions.

Effect of Rice Culture on Microörganisms of Soil.—P. L. Hibbard and A. R. Davis have compared samples of rice soil and of comparable fallow soils (as coöperative work on a rice investigation project). In so far as the findings from these samples have a general validity, they indicate that no marked change in the activities of soil organisms has been produced by the growth of rice. The following comparisons were made:

1. The total number of organisms in the surface soil of a rice plot are about one-fourth of the number in the fallow soil. The subsoil of the rice plot has about half as many as the subsoil of the fallow field.

2. Comparison of different forms in fallow and rice soils show that (*a*) the cellulose destroying organisms seem to be slightly, but not significantly more effective in the fallow soil; (*b*) denitrifying organisms are practically the same in both the rice and the fallow soils; (*c*) ammonifying power is good in both fallow and rice soil, perhaps a little stronger in the fallow soil; (*d*) nitrogen fixation is much superior in the surface of the fallow soils, but in the subsoil there is little difference between the rice soil and the fallow soil; and (*e*) nitrification of ammonium salts is practically the same in the fallow and the rice soils.

Relations of Increases in Water-Extractable Soil Constituents to their Withdrawals by Plants and to Crop Yields.—Previous studies from this laboratory by J. C. Martin (with the coöperation of J. S. Burd), based on various treatments of fertile soil, showed a general correlation between increases in the water-extractable soil constituents and the amounts absorbed by plants, even when no substantial increase in growth took place. Recent studies of an infertile soil have shown that there exists a more definite correlation of plant withdrawals with yield of dry matter than with increased solubility of most soil constituents. In the case of nitrate, the correlation between increases in water extractable nitrate is as definite as that between yield and withdrawal. The

causes of increased withdrawals in the cases where correlations between water extractable constituents and yield is not evident, are to be sought in the greater total absorbing power of the plants, and possibly in the increased production of carbon dioxide in the soil, incidental to the greater plant developmeat. While it is not suggested that withdrawals of constituents which appear to be quantitatively of secondary importance in growth are not a factor in growth, it appears that the amount of growth, however produced, is a preponderating element in causing an increased withdrawal of such constituents from the soil.

The Concentration of Phosphate in the Soil Solution According to the Displacement Method.—One of the most interesting questions of phosphate fertilization concerns the concentration of phosphate actually present in the soil solution at a given time, and the means of increasing this concentration, so as to supply plants with their full requirements. An investigation of these points has been begun by J. C. Martin (with the coöperation of J. S. Burd).

Studies of solutions displaced after the initial displacement solutions had ceased to give uniform concentrations, indicated a rise in the concentration of PO_4 concurrently with a lowered concentration of other electrolytes. This fact suggests the possibility of considerable fluctuation of PO_4 concentration in soils in the field when conditions occur which bring about a lowering of certain other electrolytes. Such a relation must inevitably increase the PO_4 concentration of soils which are subject to leaching or in which, for any reason, cations are removed. The further possibility suggests itself that removal of cations by the plant would tend to increase the PO_4 concentration in the soil at the time when the plant can best profit by such enhanced concentration.

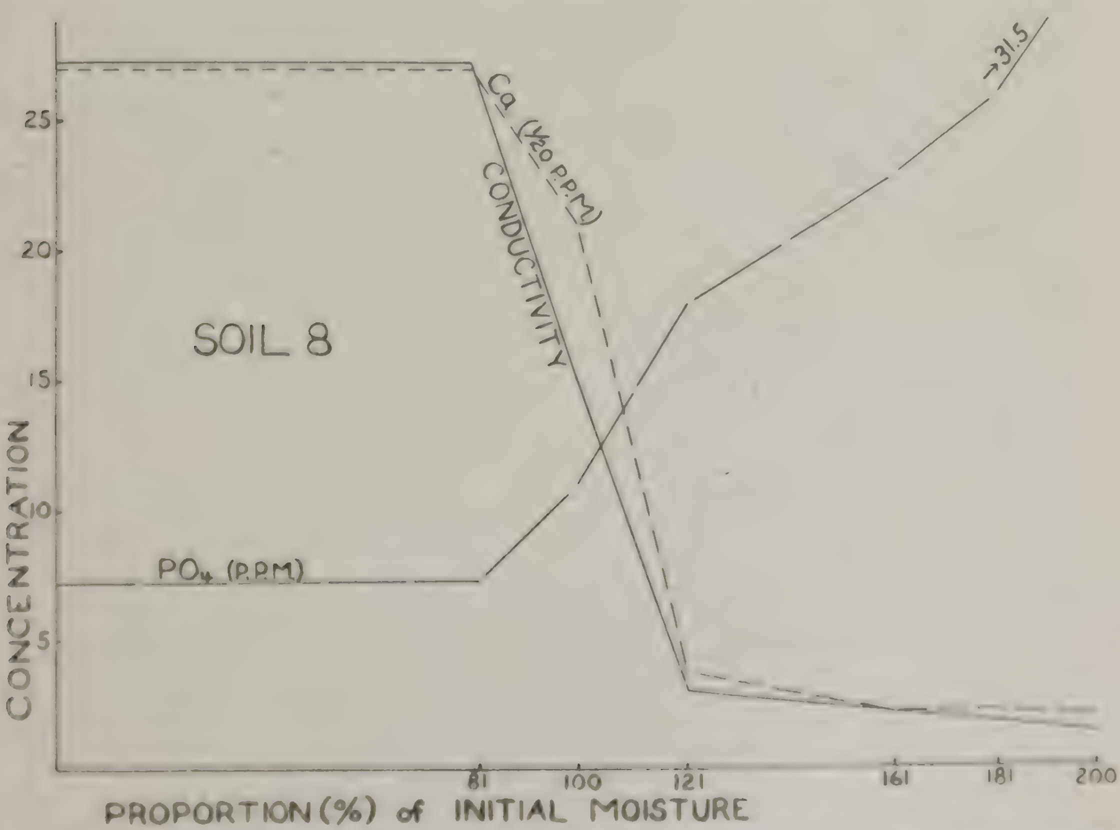


Fig. [illegible].—Typical behavior of total electrolytes, calcium, and phosphate in solution continuously displaced from soil. Note that the concentration of phosphate increases as calcium and total concentration decrease.

Protection of Piling Against Attacks by Marine Borers.—The Division of Plant Nutrition, under the general direction of Dr. C. A. Kofoid of the Department of Zoology and Professor J. S. Burd of the College of Agriculture, has coöperated with the San Francisco Bay Marine Piling Committee in an investigation of methods for the protection of piling from destruction by marine borers.

Fig. 83.—Section of piling which has been destroyed by marine borers.

W. H. Dore of the Division of Plant Nutrition and R. C. Miller of the Department of Zoology have shown that the borer, *Teredo Navalis*, partially digests the wood chips which are removed when the mollusc attacks marine structures. Analyses of the original wood and ejected boring show a loss of 80 per cent of the cellulose and of 15 to 56 per cent of the hemicelluloses during the passage through the animal's digestive tract. The results offer practical suggestions as to (1) methods of protection against teredo attack, and (2) methods of testing the toxicity of wood preservatives.

The Composition of the Soil Solution as Indicated by the Displacement Method.—J. C. Martin with the coöperation of J. S. Burd in continuing studies reported in previous years,* has utilized a modification of the Parker displacement

* Report of the College of Agriculture and Agricultural Experiment Station, University of California, 1920–21, p. 30; 1918–19, pp. 63–64.

method for obtaining the soil solution. The method has been given critical study and the results so far obtained are of great interest.

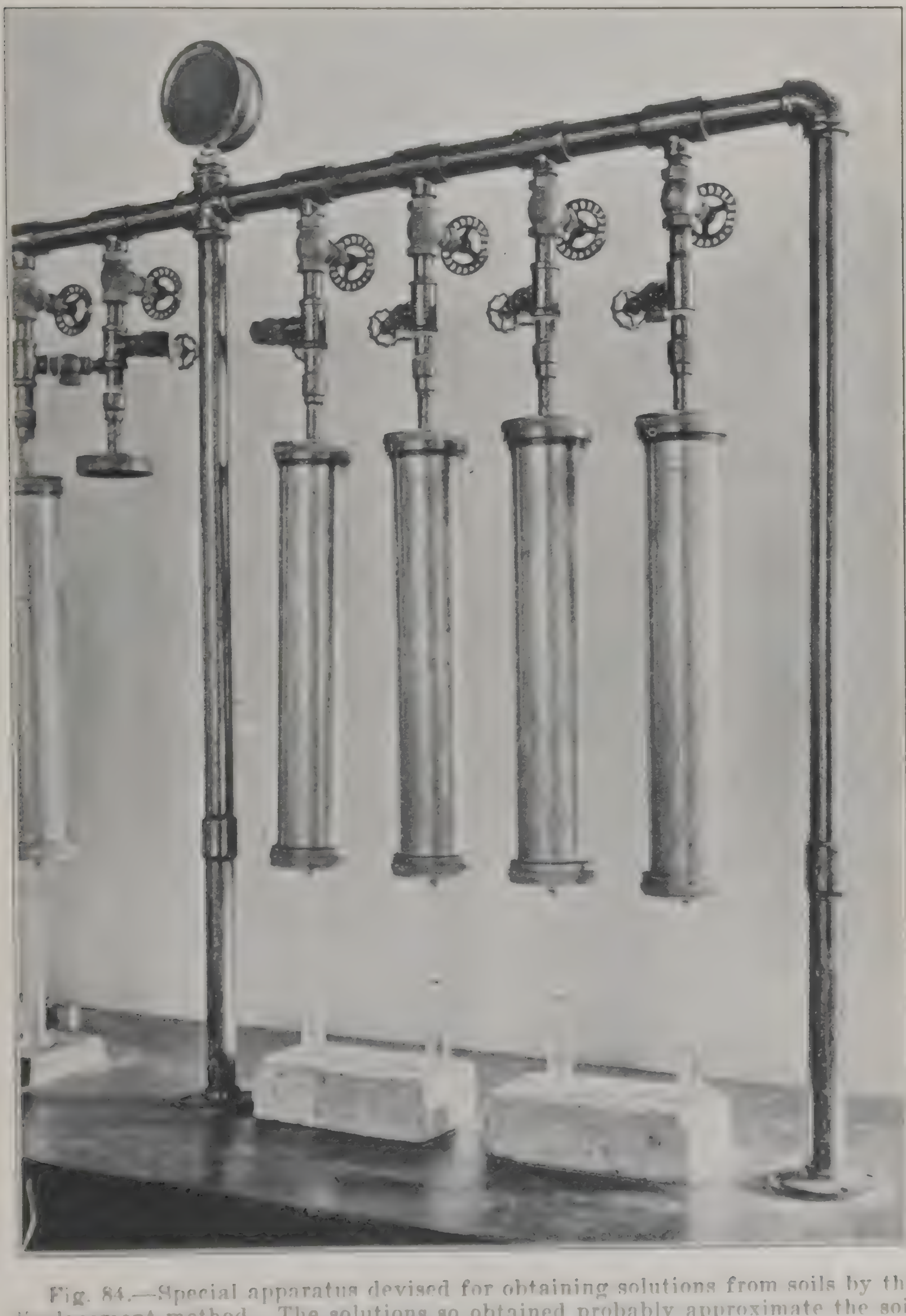


Fig. 84.—Special apparatus devised for obtaining solutions from soils by the displacement method. The solutions so obtained probably approximate the soil solution from which plants absorb mineral elements.

Aided by positive air pressure never exceeding 100 pounds per square inch, and using distilled water as the displacing medium, solutions have been displaced from closely compacted columns of soils, yielding solutions having a constant concentration, the volume being from 50 to 80 per cent of the original moisture in the soil. The concentrations of solutions displaced from the same soil at different moisture contents are inversely proportional to the total moisture. When the displaced solution from a soil was used as the displacing agent on another column of the same soil, at the same moisture content, the displaced solution was identical with the displacing agent, and the latter passed through

Fig. 85.—The effect of common salt upon the growth of barley, concentrations ranging from 500 to 8000 parts to the million. The control, C, contains no salt.

the soil unchanged, indicating that the displaced solution has the same concentration and composition as the solution with which it came in contact in the soil. Comparisons made between displaced solutions and the water extracts (1 part soil to 5 parts water) of the same soils at the same moisture content indicated that either method gave the same concentration of nitrate and chlorid (calculated to the same moisture basis). Both methods showed very similar concentrations of calcium and magnesium, although these elements were sometimes higher when determined by the displacement method but just as often lower, dependent, no doubt, on the character of the reserve calcium and magnesium minerals in the particular soil. The extraction method in every case indicated a higher concentration of potassium than was present in the displaced solution, the same being true of phosphate. In the latter, the excess was directly proportional to the excess water used in extracting.

The Influence of Common Salt on the Growth of Barley.—Experiments previously reported by A. R. Davis* have indicated that certain concentrations of common salt stimulate the growth of wheat, peas, and barley. To obtain data regarding the effect of season upon such stimulation, the same investigator

Fig. [illegible].—Cells of fresh water alga Nitella, used in studying the absorption of ions by plant cells. Approximately natural size.

* Report of the College of Agriculture and Agricultural Experiment Station, University of California, 1920–21, pp. 28–29.

has continued the work with barley during the past year. Plants were grown to maturity during several periods throughout the year, in Hoagland's solution plus sodium chlorid in amounts varying from 500 to 1000 p. p. m. The dry weight of the tops was used as a criterion of growth. Data so far obtained show that stimulation over the control is greatest in cultures grown during the winter months when lower temperatures and light values prevail. At the present time, it is impossible to separate the influences exerted by those two factors. The apex of the stimulation curve also is found at a higher concentration in the winter than in the summer months. The higher temperature and light values of the summer period undoubtedly accelerate the rate of the absorption of the salt, the toxic qualities of this latter thus being emphasized. The increased rate of absorption of salt and the increased rates of transpiration seems also to be responsible for a decreased tolerance limit. On the basis of the evidence above, one can argue that other soil conditions being equal, the same concentration of salt should be more harmful in the hot interior valleys of the state than in the cooler and more humid regions.

Absorption of Inorganic Elements by Plants.—For a number of years, D. R. Hoagland has been studying the absorption of inorganic elements by barley plants, and various items concerning the progress of this investigation have appeared in previous annual reports.* This year, D. R. Hoagland, A. R. Davis, and J. C. Martin have attacked the problem by new methods. It often happens that complex conditions can be understood most readily by first considering a simpler system. With this idea in mind, experiments have been made on a fresh water alga (*Nitella clavata*) which produces large cells (single cells sometimes reach several inches in length), from which the cell sap can be obtained almost uncontaminated. This is, of course, impossible with higher plants. The absorption of various ions by Nitella has been determined under a variety of conditions in the culture medium. The concentration of all the important chemical elements found in the cell sap is far higher than in the solution from which the ions are removed. Evidence of several types proves that nearly all the inorganic elements found in the cell sap are present in dissociated form. Potassium is not combined organically nor is it precipitated out. Other available data indicate that conditions essentially similar obtain in higher plants. These findings do not support current theories of the so-called feeding power of different plants.

It has been found that nitrate penetrates into the cell more rapidly from a slightly acid solution than from an alkaline solution. A similar condition probably exists in the case of the roots of higher plants.

One ion may influence the absorption of another ion from the culture solution; for example, chlorine ions may depress the rate of absorption of nitrate ions. Different ions penetrate into the cell at very different rates; thus sulfate ions are removed from a solution very slowly. Energy relations too must be taken into account. It has been determined that the penetration of ions into these cells takes place readily only when the cells are exposed to light for suitable periods of time.

The principles involved in the absorption of ions by plant cells in all probability are essentially similar for different plants, and consequently the conclusions arrived at from experiments on Nitella will be of great assistance in understanding similar processes in other plants.

---

* Report of the College of Agriculture and Agricultural Experiment Station, University of California, 1920–21, p. 30; 1918–19, pp. 63–64; 1915–16, p. 113.

PLANT PATHOLOGY

Diseases of the Fig.—E. H. Phillips and E. H. Smith have shown that, to a large extent at least, the principal fig troubles (smut, souring, soft rot) start from infection inside the fig and not from the exterior, and further, so far as their work went, that the inside of the fig is entirely sterile until it is entered by insects. One of the most important factors in this connection is the dried fruit beetle (*Carpophilus hemipterus*). This insect lives and breeds very abundantly in figs as soon as they begin to soften. Miss Phillips has shown that during the remainder of the year some of the typical out-of-door habitats of the beetles in the fig districts are as follows: January-March, fermenting and molding melons on the ground, rotting apples under trees, old diseased figs on the ground, and old cull figs about the dry yard; April–June, decaying oranges and grapefruit on the ground; July–August, decaying fresh fruit. It has been found that the fig smut fungus and various other decaying and fermenting organisms are common on these hosts, and that the beetles are covered with spores when they enter the figs. It has also been shown that the comparative immunity of certain fig varieties, particularly the Mission and Kadota, to smut, souring, and decay, is not due to any inherent resistance on the part of these varieties but simply to the fact that they have a tightly closed eye and a solidly filled interior, thus making difficult the entrance of insects.

The work of P. D. Caldis has confirmed the fact that figs are sterile until entered by insects, and has shown the possibility of the *Blastophaga's* being an important carrier of fig disease germs. He has also found that a very definite cryptogamic flora is transmitted from fig to fig by these insects.

Experiments on the spraying of figs are being conducted, in order to determine whether disease control can be obtained by this means.

The fact that certain fig varieties are practically exempt from disease of any sort indicates the possibility of obtaining varieties having such qualities and at the same time such other desirable characteristics as color and quality. There is particularly desired a good white fig, immune to disease and producing three crops of fruit a year without caprification. A fig like the Black Mission but with white fruit would come close to meeting these requirements. Attempts are under way to breed figs for the purpose of producing such desirable varieties. In 1922 about two thousand seedlings were grown from Mission and Kadota seed, crossed with some of the ordinary capris. In the spring of 1923 these were planted near Auburn, Placer County, in semi-permanent orchard form in order to bring them into fruiting. During the summer of 1922 Miss Phillips hand-pollinated a large number of figs, crossing the Mission and Kadota with pollen from some of the so-called Maslin seedlings, Capris, which are seedlings from edible Smyrna figs. Several thousand of these seedlings are now growing.

* Report of the College of Agriculture and Agricultural Experiment Station, University of California, 1921–22, p. 123.

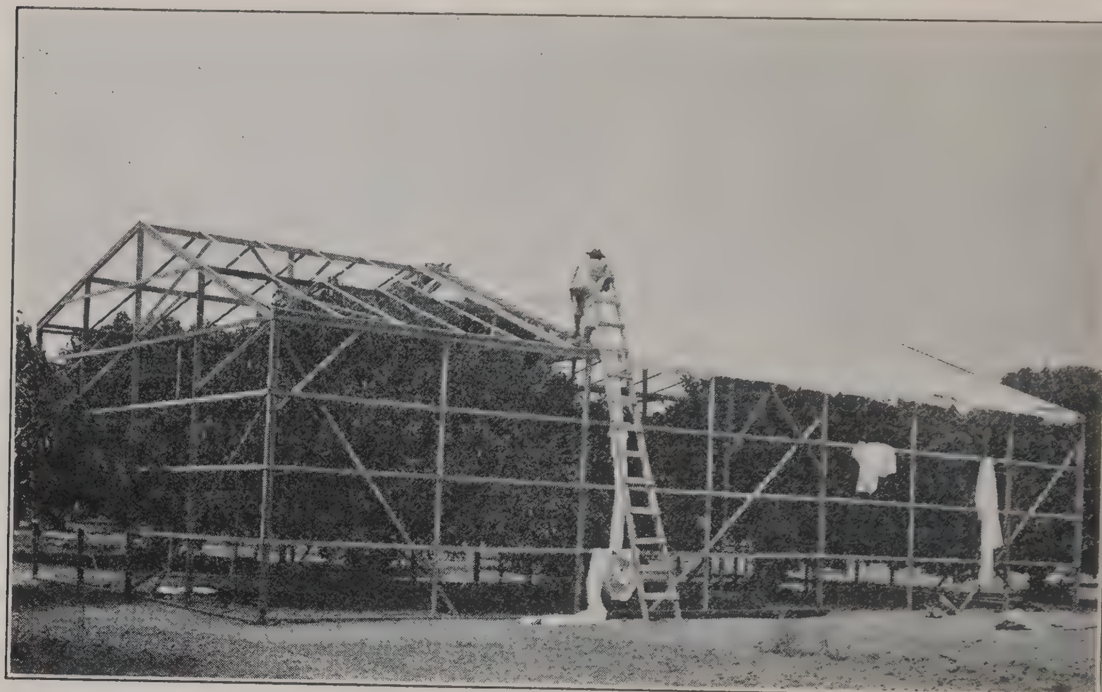


Fig. 87.—Building tent over large fig trees to exclude insects. Investigation of fig diseases.

Fig. 88.—Duster of self-mixing type, working on pea aphis.

Improved Method of Making Nicotine Dust.—The use of nicotine in the form of a dry dust for insecticidal purposes, a use which originated at this station, has come into general practice in many parts of the country. Numerous firms are manufacturing nicotine dust commercially, and entomologists and chemists in several experiment stations are carrying on investigations in regard to the preparation and use of this material. The greatest obstacle to the use of nicotine dust has been its comparatively high cost, and the difficulty and expense of factory mixing and of the commercial handling of a product composed mostly of inert "filler" and having as its essential ingredient a volatile and unstable substance like nicotine. These difficulties have now been largely obviated by the development at this station of a self-mixing dusting machine, in which the raw materials are placed in the machine in the field and the mixing and application carried on at one operation. This cuts the cost to less than one half that of factory-mixed dust and at the same time produces a more efficient material. Through coöperation by the station with various manufacturers, machines which embody this idea are already on the market and are being tried out for the control of prune thrips, pea aphis, walnut aphis, citrus thrips, and other pests.

Troubles with Canning Tomatoes.—Early in 1922 the Experiment Station was urged by representatives of the tomato canning industry to undertake an investigation of the troubles with this crop. The poor quality and quantity of the tomatoes produced were thought to be largely a pathological matter and particular attention was called to the disease called Western Blight. F. L. Yaw has made an extensive survey of the tomato growing industry of the state and has found that the troubles complained of are due mainly to Fusarium Wilt, Western Blight, and degenerate strains producing misshapen fruit of poor canning quality. He is now growing in a number of typical localities test plantings of the most promising tomato varieties and strains for avoiding these troubles. This includes improved strains of local origin and the best eastern wilt resistant sorts, particularly the Norton. Acre plantings have been made in each instance and a quantity of tomatoes of each variety will be canned in order to obtain the final test of canning quality. The various plantings and varieties will also be used for pathological study.

Winter Injury and "Sour Sap" Disease in Deciduous Fruit Trees.—The extensive dying of fruit trees which occasionally occurs in California during the winter and spring months constitutes one of our most destructive plant troubles. So common and widespread is this occurrence that many growers have come to look upon it as an almost normal, or at least an unavoidable condition, and it was only the insistence of Placer County plum growers that caused J. P. Martin (Plant Pathology) to be assigned to the investigation of this problem in September, 1922. Fortunately for the success of the investigation, if not for the grower, the spring of 1923 was marked by a widespread epidemic of sour sap in all of its various forms. Thus far Martin has found that:

1. Several distinct diseases or injuries are being confused under the name sour sap.

2. Included among these is a considerable amount of a specific infection, the so-called bacterial gummosis caused by *Pseudomonas cerasus* Griffin, previously

studied in California by J. T. Barrett and E. H. Smith.* This disease affects the cherry, plum, apricot, peach, and almond. It is a winter infection and largely attacks trees weakened by climatic or other conditions.

3. Other forms of so-called sour sap are caused directly or indirectly by injurious climatic conditions and by soil moisture conditions.

4. Thermograph records show that in some localities where winter injury occurred, the minimum temperature was lower and the maximum temperature higher than in unaffected localities. A daily range of 50° F. was observed in one instance.

Fig. 89.—Effects of ''sour sap'' or winter injury in young orchard.

5. It was found that the minimum temperature was lowest and the maximum highest near the surface of the ground, the point where the trees often are most affected, and the minimum grew higher and the maximum lower as the distance above ground increased.

6. Martin found that a coating of whitewash applied to the trunk of the trees in early winter showed a tendency to prevent some forms of sour sap, including bacterial gummosis.

7. The temperature inside the trunks of trees thus whitewashed was considerably lower during sunlight than in trees not thus protected.

8. ''Cold Water Paint'' was found to be a good material for this purpose.

9. Trees top-grafted at least three feet from the ground on certain seedling stocks were found to be practically immune to all forms of winter injury. Among such stocks the peach, myrobalan, bitter almond, mazzard cherry, and morello cherry were found to be the best, each being adapted to certain uses.

10. Lack of drainage was found to be connected with the trouble in many, though not in all, instances. The Division of Soil Technology is investigating this phase of the subject.

* Report of the College of Agriculture and Agricultural Experiment Station, 1920–21, p. 62; 1921–22, p. 74.

11. Trees regularly sprayed in the fall and spring with Bordeaux mixture according to the usual peach schedule showed some evidence of control of bacterial gummosis.

Brown Rot of Apricots.—The control of the blossom and twig blight form of the brown rot of the apricot and other stone fruits, a disease which threatened to exterminate the apricot industry in the San Francisco Bay region, is now practically assured by the work of B. A. Rudolph of the Division of Plant Pathology. Extensive demonstrations and experiments in spraying and orchard sanitation were carried on during the past season, largely in coöperation with various county farm advisors. In some of the localities which usually are most affected, peculiar climatic conditions reduced the outbreak of the disease to a minimum and seemingly rendered the work of control unnecessary. Much good was accomplished, however, through the education of the growers, and the fact that the disease was inactive for a season gave opportunity to reduce more completely the enormous amount of infection which has been present in many orchards.

That the brown rot fungus (*Sclerotinia cinerea* (Bon) Schröt) is unable to make its attack upon the blossoms in the absence of moisture, was most strikingly demonstrated during the spring of 1923 in the more important apricot producing communities of central California, where the inroads made by the disease are ordinarily most severe. The almost unprecedented drought throughout the entire months of February and March rendered difficult, it not impossible, the germination of the spores of the fungus. Not only were rains totally absent, but the entire blooming period was singularly free of fogs and other forms of precipitation. This was particularly true in Alameda and Santa Clara counties.

At Hollister and Aromas, however, several foggy nights and mornings occurred during the blooming season with the result that in unsprayed orchards extremely serious outbreaks of the disease occurred. Rudolph, with a working party of four men, has again found* that great success was obtained with sprays in these localities for the control of the disease, both in the University demonstration plots and in privately owned orchards. While counts made at Hollister and Aromas are not yet complete, sufficient data have been compiled to verify the results obtained experimentally during the past several years. Many growers have adopted with success the multiple spray method in those orchards where heretofore the disease has stubbornly resisted a single application of standard Bordeaux counts obtained showed that, invariably, better results are obtained from two or more applications of spray than from one, also that Bordeaux 8–8–50 (Double Standard Strength) may be expected to give better results than any other standard fungicide.

At Hayward, Rudolph with the financial assistance of the Canners' League, the Prune and Apricot Growers Association, and the Alameda County Farm Bureau, conducted a demonstration of the most suitable methods of controlling the disease. The almost complete absence of brown rot in that vicinity, however, due to the unusually dry climatic condition in the vicinity during the blooming period, gave little opportunity to show the effectiveness of such methods.

* Report of the College of Agriculture and Agricultural Experiment Station, University of California, 1921–22, p. 118.

Fig. 90.—Bacterial gummosis of plum, showing killing of buds and production of gum.

In addition to the demonstration work at Hayward, experiments were made with several new fungicides and with modifications of old formulae in an attempt to find, if possible, a better spray than Bordeaux 8–8–50.

Spraying experiments for the control of brown rot in ripe fruits are being continued.* The control of this disease in ripe apricots involves many difficulties. The apricot is one of the very few fruits which is not peeled before canning; for this reason, sprays which leave a precipitate or deposit of any kind cannot be used late enough to control the disease effectively without rendering the fruit unfit for cannery use. In addition, the apricot is very sensitive and is readily sprayburned or injured by many of the commoner soluble spray materials. Until some fungicide can be found that does not stain or injure the fruit, is soluble in the wash water of the cannery or packing house, and at the same time effectually controls the disease, it is recommended that the orchards be kept in a thoroughly sanitary condition, thereby reducing the spring infections to a minimum and rendering less possible the infection of the fruit at harvest time.

Coöperating with the Extension Division, B. A. Rudolph and H. L. Washburn conducted several experiments in Santa Cruz County for the control of Monilia twig and blossom blight (brown rot) in prunes. Since climatic conditions were wholly unfavorable to the development of the disease this spring in Santa Cruz County, it will be necessary to repeat the experiments next season. Rudolph has also carried on Extension work on brown rot in Sonoma, Napa, Solano, Yolo, Stanislaus, Ventura, Santa Barbara, and other counties. County Farm Advisors Robinson, Tocher, and Mayhew assisted greatly by coöperating in the work on brown rot.

Blue Stem of Raspberry.—A serious disease of raspberries due to a *Verticillum* fungus has been studied by E. H. Smith. This fungus attacks the canes near the surface of the ground and is spread by cuttings. It is very similar to the so-called blue stem of the northwestern states, both in appearance and in causative fungus. B. A. Rudolph at Mountain View is conducting experiments in order to determine the mode of infection of this disease and also its relation to blackheart of apricots, a disease caused by a similar fungus. A large patch of the very susceptible Ranoree variety has been set aside for this purpose.

Minor Apple and Pear Diseases.—Many fungous diseases of the apple and pear, though of considerable importance in other parts of the country, are not conspicuous in California on account of the dry summers. Nevertheless they do some damage in this state in the hill districts and near the coast. A study of these has been continued by E. H. Smith, several new diseases having been determined during the past season. Of these the following may be mentioned: Monilia sp., causing a blighting of blossoms and new growths with much the appearance of bacterial blight, chiefly found on the Madeleine pear; Botrytis sp., causing twig die-back of pear, from Antelope Valley and like situations, described recently by Zeller of the Oregon Station; and *Plenodomus fuscomaculans* (Sacc.), causing apple bark cankers, the bark finally separating from the wood and falling in shreds.

* *Ibid.*, 1920–21, p. 61.

Bacterial Spotting of Stone Fruits.—Studies of bacterial infection in stone fruits have been continued by E. H. Smith. Since lesions very suggestive of the Eastern "black spot" are prevalent here, appearing as leaf and fruit spotting and cankering on the new shoots, a careful comparison has been made of the black spot bacterium (*B. pruni* Smith) with certain yellow organisms associated with the California lesions. The true black spot has not been found here, the damage mentioned being caused by the bacterial gummosis organism, *Pseudomonas cerasus* Griffith.

Fig. 91. Typical packages of diseased plants received for examination by the Division of Plant Pathology.

Vegetable Rots.—Field rotting of various vegetables, a trouble unusually prevalent this season, has been given some attention by E. H. Smith. This includes a celery crown rot of the delta region found to be due to the soft rot organism (*Bacillus carotovorus*), a serious rot of sugar beets due to the fungus *Rhizoctonia solani* recently reported by Richards as doing damage in Utah, and a spotting and decay of lettuce as yet undetermined.

Miscellaneous Plant Disease Studies.—One of the most important parts of the work of the Division of Plant Pathology consists in the examination and study

of specimens of diseased plants sent in by the public and the giving of advice regarding the treatment of these troubles. Figure 91 represents the material of this sort which came in one mail during the busy season. These packages come from growers of all kinds of crops, city lot gardeners, nursery men, county and state horticultural officials, and county farm advisors. Oftentimes large financial interests are involved in the decision as to the identity of the trouble represented. The contents of each of these packages often requires much study and possibly field examinations and experiments before the problem can be considered satisfactorily solved. About one thousand such cases have been handled during the past year by E. H. Smith, W. T. Horne, and R. E. Smith.

Apple Sappy Bark.—Some new phases of this important apple disease have been studied by W. T. Horne. In Napa County vigorous Gravenstein trees were found exuding dark colored sap on larger limbs and trunk, simulating the peculiar disease known as slime flux. Examination showed that this material was being forced out of openings the size of pin holes, in some cases with slight bubbling, through the bark and outer wood. Digging a short way into the sapwood showed that very active and wet decay was in progress in the middle of the limb and that only a rather thin outer layer of wood was still healthy. While it has not yet been possible positively to identify the fungus involved, it is evidently a typical case of sappy bark disease caused by oyster shell fungus, *Polystictus versicolor*, and infection had taken place at rather large pruning wounds. In this case the wounds had been treated conscientiously but evidently not successfully—presumably treatment had not been prompt enough. Sappy bark is frequently associated with dark exudation from infected pruning wounds but exactly this behavior had not before been noted. Such cases are important, since the trees can doubtless be saved with small loss of vigor if they are skillfully treated by suitable tree surgery methods, but if neglected, they will soon decline with consequent loss of limbs and will become rotten snags.

Armillaria Disease or Oak Root Fungus.—W. T. Horne has for several years been studying the possibilities of chemical treatment of soils to eradicate this fungus and, in cooperation with the Division of Pomology and with various county farm advisors, has been testing various root stocks and methods of propagation in the hope of obtaining some means of resistance to the fungus.* During the past year favorable results from the use of carbon disulfid have been obtained. A phase of the matter less important in California than in sections farther north has been called to our attention by Farm Advisor Weinland and the observation confirmed by Horne. Crown infection of Gravenstein apples occurs in the rainy sections north of San Francisco Bay. Gravenstein is apparently markedly susceptible. Where the stock is resistant, however, there should be little difficulty in protecting such trees by annual winter inspection and by scraping away rhizomorphs and diseased bark and then painting with Bordeaux paste or other disinfectant. Trees worked high on Delicious stock on its own roots are being tried for resistance. This is based on Whitten's experience in Missouri where Delicious was found to be very resistant.

* Report of the College of Agriculture and Agricultural Experiment Station, University of California, 1920–21, p. 62; 1921–22, p. 137.

POMOLOGY

Almond Breeding.—In 1918 and 1919 seeds obtained from the almond breeding experiment carried on by W. P. Tufts and G. L. Philp were planted, the object being to try to develop a new almond that would bloom late and yet retain the good characteristics of the most important almond varieties. During the past year (1922) a large number of the hybrid seedling trees came into bearing for the first time. Observations made by M. J. Heppner show that there are some trees in the seedling block that give promise of producing the desired results, although it is impossible to draw any definite conclusions as to the future value of the new almonds from one year's study.

In a study of the characteristics of the seedlings, it was noticed that all the trees did not possess sweet almonds, although the parents of the hybrids were sweet in every case. Out of the 243 trees that came into bearing, there are 59 with bitter and 184 with sweet almonds. It will be noticed that there is nearly a perfect three-to-one ratio when the totals are considered. This close approximation to the theoretical Mendelian monohybrid ratio indicates that all the almond varieties represented in this test are heterozygous for sweetness of the kernel. Owing to the manner in which this character has segregated, an hypothesis can be drawn, namely: all varieties of sweet almonds are hybrids, having the genetic constitution bB, where b represents the factor for bitterness as the recessive character and B the factor for sweetness as the dominant character. When two almond varieties are crossed the characters segregate out as follows:

1 BB:	2 bB:	1 bb
Sweet	Sweet	Bitter

In order to test this hypothesis, a large number of the seedlings were crossed back to the parents during the present year (1923). The nuts obtained from these crosses will be planted and further observations made on the resultant seedlings.

Factors Correlated with Bitterness in the Almond.—Fred Lohse, a junior student working under the direction of M. J. Heppner, endeavored to find whether correlation exists between bitterness in the almond and any external or internal characteristic of the tree.

Six months' work seems to indicate that there is no correlation between any external characteristic and bitterness. However, there does appear to be a correlation with certain physiological characteristics. When twigs from a bitter tree were placed in a solution made of two parts distilled water and one part ammonium sulfocyanid, or potassium sulfocyanid, and allowed to remain for twenty-four hours, the distinguishing odor of amygdalin was given off but no change took place in the color of the pith. When a similar test was made with twigs from a sweet almond tree, no characteristic odor of amygdalin was detectable, but the pith turned brown.

Further experiments are necessary before the exact reasons for these reactions can be explained. Should the above tests be found to hold true for all cases, however, they will be of great value in future almond breeding work. It will be possible to cull out all bitter almond trees while in the nursery row instead

of waiting for the trees to come into bearing. Up to the present time it has been necessary to follow the latter method.

Chlorosis of Pears and Raspberries.—Experiments with chlorotic pear trees carried on by A. H. Hendrickson confirmed tests of previous years.* Ferrous sulfate applied next to the roots caused the foliage to turn to a normal green color. The effects of one application remained for at least three years. The application of ferrous sulfate the last week in May was not as effective as that applied in March. Neither barnyard manure applied in trenches nor nitrate of soda broadcasted on the soil caused any visible change in the chlorotic appearance of the trees.

Raspberries were also treated in the early spring with ferrous sulfate and almost immediate results were obtained. The leaves of the treated plants were normal in color, and the fruit was larger than on the chlorotic plants. Experiments are now under way in the use of sulfuric acid, gypsum, and sulfur.

The Effect of Storage Temperature upon the Keeping of Apples.—The effect of storage temperature upon the keeping of apples was studied by J. L. Fidler, under the direction of E. L. Overholser. With few exceptions, temperatures of 30° to 32° F., proved most satisfactory. The varieties tested kept, on an average, nearly a month longer at 32° F. than at 36° F. The development of scald and blue mold was delayed and lessened by a temperature of 32° F., as contrasted with higher temperatures.

As opposed to the behavior of most varieties, the Jonathan kept better at 36° F. than at 32° F. Limited data indicate that dessert apples, especially those of delicate texture, may be more satisfactorily kept at slightly higher temperatures than the firm fleshed, long keeping varieties. The Yellow Newtown was another exception in that it kept better at a temperature of 40° F., because of the lessened development of internal browning.

At 45° F., or a temperature approximately that of refrigerator cars, nearly all varieties failed from wilt, scald, and blue mold (*Penicillium expansum* Link). Delay and careless handling in placing apples in storage materially increased the loss from these troubles with apples stored at 45° F. Yellow Newtown apples that were delayed nine days before being placed in storage failed from rot over a month earlier than specimens stored three days after harvesting.

Each variety of apple exhibited a characteristic method of failure in storage. Apples having high quality appeared first to lose the aroma, then to deteriorate in quality, and gradually to break down internally and become mealy in texture. This was particularly true of the Grimes.

Relative Keeping Quality of Apple Varieties in Cold Storage.—J. L. Fidler, under the direction of E. L. Overholser, made observations during one season on the behavior of apple varieties in cold storage. These varieties are arranged in the following list in the order of their keeping qualities: Winesap, Hoover, Ben Davis, Gano, White Winter Pearmain, Stayman Winesap, Virginia Beauty, Winter Banana, McIntosh, Yellow Newtown, Yellow Bellflower, Rome, Wagener, Delicious, Jonathan, Oliver, Smith Cider, Rhode Island, Tompkins King, Grimes, and Gravenstein. The first six varieties kept in good condition until after May 15. The summer varieties kept in the following order: Red June, Early Strawberry, Yellow Transparent, Chenango, Summer Pearmain, Early Harvest, Sweet June, Red Astrachan, White Astrachan, Keswick Codlin.

* Report of the College of Agriculture and Agricultural Experiment Station, University of California, 1921–22, p. 134.

The good keeping qualities of the Yellow Bellflower was a striking fact determined. This apple has not been considered a storage variety by growers in California, but in these tests Yellow Bellflower apples from the Oak Glen district of San Bernardino County, picked when firm ripe, on October 23, 1922, and placed at 32° F., remained in good condition until the following May and retained the quality and flavor better than the average stored variety. Two shipments from the Sebastopol region, stored September 23 and October 14, kept nearly as well.

Fig. 92.—Severe browning of the Yellow Newtown apple.

Jonathan apples kept better than is generally reported, the average maximum storage date being about March 15. They wilted considerably and were slightly affected with Jonathan spot, but retained their excellent flavor.

Wilting of Apples in Cold Storage.—Certain varieties of apples were found by J. L. Fidler, under the direction of E. L. Overholser, to wilt badly in storage as a result of transpiration when the relative humidity of the storage room was low. In wilting, the firm, crisp texture of the fruit was lost, and the flesh and skin became more tough. The fruit was, therefore, not so desirable for eating in the fresh condition, although it was good for culinary purposes. Immature apples always wilted more severely than mature specimens. Apples kept at 32° F. in an atmosphere of a comparatively high humidity remained in better condition with less wilting than those stored at temperatures of 36° and 45° F.

The Jonathan apples during the 1922–23 season wilted more than any other variety tested, although they were remarkably free from rot and scald. Other varieties seriously injured by wilting were: McIntosh, Wagener, Grimes, Virginia Beauty, Ben Davis, Gano, Hoover, Stayman Winesap, White Winter Pearmain, Yellow Bellflower, Winter Banana, and several of the summer varieties, especially when harvested prematurely.

Studies of the Darkening of Apple Tissue.—Studies by E. L. Overholser and W. V. Cruess have been continued* upon the factors involved in the darkening of apple tissue. The oxidizing system concerned in the browning of apple tissue is considered as consisting of a peroxidase and an organic peroxide. The peroxidase transfers to the compound to be oxidized, the oxygen derived from the organic peroxide occurring in the fruit or that derived from added H_2O_2 and behaves as an activator or accelerator. The organic peroxide is considered as resembling hydrogen peroxide in its behavior and in the presence of the peroxidase liberates oxygen in the active state.

Effect of Maturity at Harvest upon Apples in Cold Storage.—J. L. Fidler, under the direction of E. L. Overholser, studied the effect of the stage of maturity at harvest upon the behavior of apples in cold storage. The Gravenstein and Delicious in particular were observed. Evidence was obtained which indicated a tendency in Sonoma County to pick the Gravenstein prematurely. One year's observation showed that the Gravenstein kept well in storage until after Christmas if allowed to mature on the trees until firm ripe before being harvested. The Gravenstein picked too early was badly affected in storage with bitter pit and lacked the quality and flavor of the more mature fruits. Well matured but not overripe fruit kept better, was more attractive in appearance, and was of superior quality when stored.

On the other hand the data indicated a tendency in Sonoma County to permit the Delicious to become too ripe before harvesting. Early harvested Delicious apples kept longer in storage and were of better quality, flavor, texture, and juciness than those harvested at the time of the average commercial picking. Late harvested fruits became mealy and lost their aroma soon after being stored. In these experiments Delicious apples harvested as early as four weeks before the average commercial picking, although they lacked color, were of better quality after three months' storage than the commercial picking. Those harvested two weeks previous to the commercial picking had good color, were of better quality, and kept much longer than those harvested at a later date.

The Delicious has not been recognized as a late keeper, but the picking made two weeks previous to the average commercial picking kept in excellent condition at 32° F. until May 1. When Delicious apples were allowed to remain on the trees, they "water cored" badly, and the loss from dropping was great, especially during the season of 1922 when early fall rains occurred. It is difficult to determine from the external appearance whether apples have "water core" (see fig. 93). Affected specimens break down and deteriorate rapidly in cold storage. Some storage men are of the opinion that the "water core" disappears in storage and is not noticeable after a time, but in these experiments it was not found to be the case. During the season of 1922, late harvested Delicious apples failed in storage from "water-core."

Experiments indicate that each variety of apple has an optimum period when it should be harvested, and that it is necessary to be familiar with the characteristics of each variety to know the proper harvest time. As a rule, however, all varieties of apples tested kept best in cold storage when harvested after they had reached the firm ripe stage but before they became overripe.

* The results of this investigation are reported in full in Technical Paper No. 7, of this Station, June, 1923.

Bitter Pit of Apples in Cold Storage.—Bitter pit is a condition wherein certain groups of cells in the subepidermal tissue become dark brown in color and dry and corky. The condition may also develop deeper within the fruit. When near the surface the areas shrink and cause "pits" or depressions (fig. 94).

J. L. Fidler, working under the direction of E. L. Overholser, found bitter pit to be the limiting factor in the cold storage of certain varieties of apples. Bitter pit appeared to develop suddenly. After the affected areas were once isolated, they did not seem to grow larger in size.

Fig. 93.—Water core of the late picking of the Delicious apple. The figures show an internal and external view of the same specimen. Water core apples fail rapidly in cold storage.

One season's observation showed that summer apples were less resistant to bitter pit than fall and winter apples. Varieties susceptible to the development of bitter pit, listed in the order of their susceptibility, were: White Astrachan, Early Harvest, Keswick Codlin, Sweet June, Red Astrachan, Gravenstein, Summer Pearmain, Tompkins King, Winter Banana, Rhode Island, Bellflower, Smith Cider, Grimes, and Virginia Beauty. The varieties which developed no bitter pit were Jonathan, Ben Davis, Gano, Winesap, Stayman Winesap, Hoover, Yellow Newtown, White Winter Pearmain, McIntosh, Delicious, Wagener, Oliver, and Rome.

Apples mature when harvested developed less bitter pit in cold storage than those immature when picked. The early pickings of Gravenstein apples, harvested July 18 to 26, developed in cold storage 33 per cent bitter pit; the mid-season pickings, harvested August 2 to 8, developed 19 per cent; and the late pickings, harvested August 15 to 26, developed 9 per cent bitter pit. Furthermore, bitter pit occurred more largely on the less mature side, and on the calyx half of each specimen.

Large specimens of each variety developed more bitter pit in cold storage than medium or small sized fruit. Gravenstein apples picked July 26, 1922,

and stored at 32° F., on December 30, had developed bitter pit as follows: large specimens, 88 to the box, 98 per cent affected; medium sized, 150 to the box, 28 per cent affected; and small size, 166 apples to the box, 51 per cent affected.

Gravenstein apples from the Gold Ridge sandy loam soil of Sonoma County developed less bitter pit in storage than fruit grown upon either the river bottom or bench land type of soil. Less bitter pit resulted in apples stored at 32° F. than in those stored at either 36° F. or 45° F. One year's data indicate that the age of the trees did not materially affect the subsequent development of bitter pit in storage, provided the fruit of each lot was equally mature when harvested.

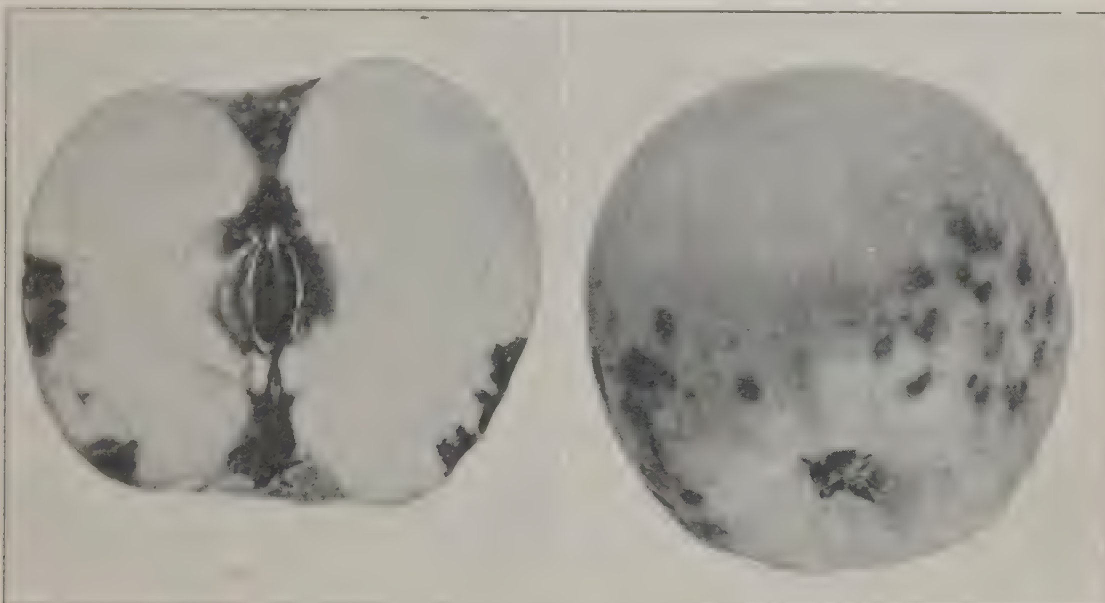


Fig. 94.—Typical bitter pit of Gravenstein apples after four months storage at 36° F. The figure on the left shows an internal view; the figure on the right an external view of the same specimen.

Apple Scald in Cold Storage.—Scald is a serious disease affecting apples in cold storage. Investigators report it as resulting from the deleterious effects upon the epidermal tissue of gases given off from the apples. The skin of the fruit becomes brown and in the later stages the apples have a "baked" appearance (fig. 95). It is checked in cold storage by low temperature and good ventilation, and by the use of oiled wrappers.

J. L. Fidler, working under the direction of E. L. Overholser, from one year's observation of apples stored at 32°, 36°, and 45° F., determined the relative susceptibility of several varieties to scald. Those scalding worst, in the order of their susceptibility, were as follows: Rhode Island Greening, Tompkins King, Wagener, Rome, Oliver, Yellow Newtown, Smith Cider, Yellow Bellflower, Grimes, Virginia Beauty, Delicious, White Astrachan, McIntosh, Gravenstein, Winter Banana, and White Winter Pearmain. The winter varieties that showed little or no scald as late as May 15 were the following: Stayman Winesap, Gano, Winesap, Ben Davis, Jonathan, and Hoover. The summer apples that showed little scald were as follows: Yellow Transparent, Red June, Early Strawberry, Summer Pearmain, and Chenango.

Immature apples invariably scalded more severely than those more mature. Furthermore, the side of each fruit most immature, as indicated by less color. scalded first. Large apples were more affected than medium sized or small specimens. Breakdown and rot of the fruits closely followed scald in storage or on removal to warmer temperatures. Delay in storing fruit after it was picked increased the development of scald with apples that were wrapped and packed in boxes.

Factors Influencing the Development of Internal Browning.—From one to five years' study of factors influencing the development of internal browning of the Yellow Newtown apple have been completed by E. L. Overholser, A. J. Winkler, and H. E. Jacob. Internal browning is defined as a non-parasitic disease of the large isodiametric cells of the flesh of the fruit (fig. 92). It was found that the Yellow Newtown, regardless of where grown, was in some years susceptible to internal browning, and further, that when grown in the Pajaro Valley it was more susceptible to this disease than when grown in other fruit regions.

The chief causes of the browning appeared to be due to late harvesting and to delay in placing the fruit in cold storage after harvesting. The specific cause of the browning appeared to be due to the accumulation of essential oils or similar deleterious substances which are produced by the apples in storage. This would indicate that internal browning and apple scald are quite closely related with respect to cause.

Besides a paper published by Winkler,* a full report of this investigation has been published in a bulletin† of this Station.

Freezing Fruit for By-Product Use.—Under the direction of E. L. Overholser and W. V. Cruess, J. G. Brown conducted further experiments upon the preservation of fruits in the fresh condition for by-product use by means of freezing temperatures.

(1) Strawberries, blackberries, raspberries, loganberries, cherries, apricots, peaches, figs, and grapes stored in sealed containers with sugar, or covered with sugar solutions, were kept frozen at a temperature of 10° F. for six months without loss of their original color or flavor.

(2) Fruits frozen in sugar solutions preserved their texture better after thawing than fruits mixed with sugar alone or frozen in water.

(3) The chemical composition of the fruit did not change sufficiently while frozen for six months to alter the quality of the fruit.

(4) In the Fruit Products Laboratory the frozen fruits were found satisfactory for making jams, jellies, preserves, pie-filling, ice creams, and desserts.

(5) The berries, apricots, peaches, and cherries were found more satisfactory for use as pie-fillers than for other purposes. For this use the berries, apricots, and peaches were most desirable when crushed and mixed with an equal weight of sugar before freezing. The cherries were best when stemmed, pitted, and mixed with one-fourth their weight of sugar before freezing.

(6) The berries used for jams and preserves were most satisfactory when whole and mixed with an equal weight of sugar before freezing; apricots and peaches were most desirable when stored in a 30 to 45 per cent sugar solution.

* A study of the internal browning of the Yellow Newtown Apple. Jour. Agri. Res., vol. XXIV, no. 2, April 14, 1923.

† E. L. Overholser, A. J. Winkler, and H. E. Jacob, "Factors Influencing the Development of Internal Browning of the Yellow Newtown Apple," Bull. 374.

(7) Figs were satisfactorily held in freezing storage for preserves. The customary practice during the "peak" of the harvest period is to can them in water in No. 10 tins temporarily, to retain them for subsequent use in making preserves. The evidence obtained indicates that the freezing method is the cheaper of the two, that it permits the figs to be more rapidly handled during the rush of the harvest season, and that it is otherwise equal in every respect to the canning method.

(8) Strawberries and raspberries frozen in a 60 per cent sugar solution were as good to eat served with cream or from the hand as fresh fruits (fig. 96). The same was true with figs frozen in a 45 per cent sugar solution, and grapes were excellent to eat from the hand when frozen in a similar solution.

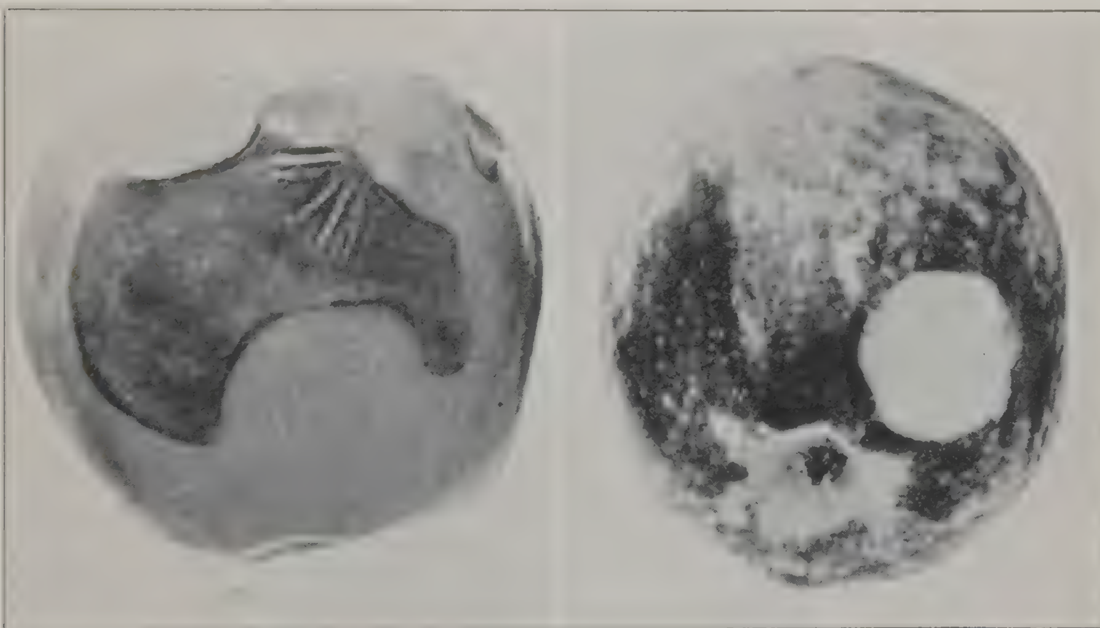


Fig. 95.—Yellow Bellflower on the right showing typical surface scald which, as the cut area shows, does not extend beneath the skin. The specimen on the left shows soft scald on the Jonathan. The Rome Beauty is also affected by soft scald.

(9) The freezing did not affect the subsequent rate of sugar diffusion into the fruit during the preserving process.

(10) The pectin content of fruits did not appreciably change during the time they were in freezing storage.

The Effect of Carbon Dioxide as a Means of Preserving Fresh Fruits.—Preliminary experiments have been conducted by E. L. Oversolser to test the value of carbon dioxide as a means of preserving deciduous fruits in the fresh condition. The concentration of carbon dioxide employed has been varied from only slightly above that normally present in the atmosphere to nearly pure carbon dioxide surrounding the fruit in closed containers. In addition, sufficient carbon dioxide was forced into vessels containing fruit to give a pressure of fifteen pounds. So long as the fruit was retained in pure carbon dioxide in closed vessels, it exhibited a fresh appearance for a longer period of time than fruit kept at similar temperatures in ordinary atmosphere. The lower the temperature, down to 32° F., at which stored, the better the fruit kept in carbon dioxide. Upon removal from the gas, however, the fruit always

had a noticeable, unpleasant, carbonated flavor and invariably turned brown quickly, through oxidation, and became soft.

The experiments so far do not indicate a definite promise for the successful use of carbon dioxide in the preservation of fruits in the fresh condition.

Cold Storage of Cherries.—Cherries are not generally kept in cold storage. Nevertheless, shipment to eastern markets in refrigerator cars essentially amounts to a storage at approximately 45° F. for from five to eight days. Furthermore, shipments by refrigerator vessel through the Panama Canal would necessitate storage at the proper temperature for about three weeks. R. J. Platt and F. R. Hodgson, under the direction of E. L. Overholser, conducted preliminary experiments to determine the keeping qualities of cherries at cold storage temperatures.

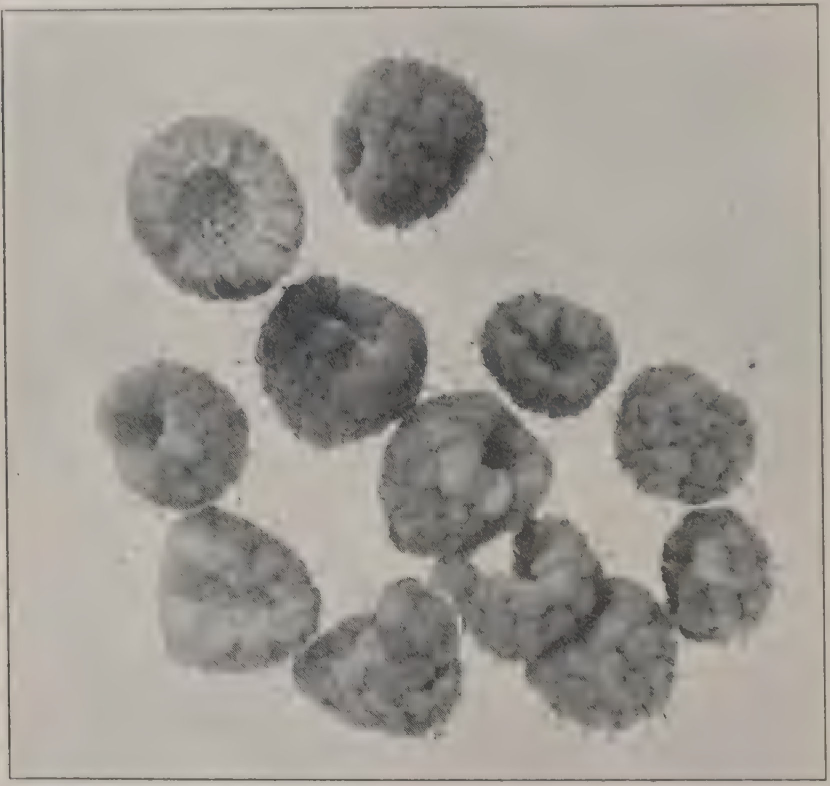


Fig. 96.—Thawed red raspberries which had been preserved in a 60° Balling sugar syrup and stored at a temperature of 10° F. for six months. In flavor as well as appearance these berries were in perfect condition at the end of the period.

Varieties of cherries with dark flesh, well ripened when harvested and normally having a high sugar content, were stored satisfactorily at a temperature of 26° F. for a period of six weeks. This is a temperature 6° F. lower than recommended for most fruits, and indicates that cherries, which are rather quickly perishable, might be successfully stored at a temperature several degrees below 32° F. without freezing. The sugar content of the varieties stored at 26° F. was comparatively high, ranging from 22 to 26 per cent, and this probably prevented the freezing of the fruit. The average keeping period at a temperature of 32° F. was four weeks; at 36° F., three weeks; and at 45° F., two weeks.

The varieties that kept longest at 32° F. were Napoleon (Royal Ann), Republican, Black Tartarian, and Windsor. Varieties that exhibited inferior keeping qualities in storage were Giant, Hoskins, Lambert, and Chapman.

Effect of Storage Temperature in Keeping Pears.—Studies upon the effect of temperature in checking the ripening of pears have been continued by E. L. Overholser and L. P. Latimer.[7] The data reported last year indicated that pears picked at the proper stage of ripeness kept better and longer at a temperature of 30° F. Commercial cold storage men, however, hesitate to employ a temperature of 30° F., owing to the fact that, with the difficulty of closely regulating the temperature uniformly throughout large rooms, the leeway for temperature fluctuations is limited. From this viewpoint the temperature of 32° F. was most satisfactory.

Fig. 97.—The specimen on the right is a Bosc pear of the commercial picking (September 1); the one on the left of the optimum picking (September 10). The photograph, taken January 15, illustrates the difference in size and also the degree of wilting when stored at 32° F.

It is interesting to note that pears picked in an immature state kept better in storage at 36° than at either 30° F. or 32° F. This proved true with the Howell, Forelle, Gray Winter, Vicar, Louise, and Bosc. For example, the Bosc, when picked too green, did not ripen properly when stored at 30° F. The fruit either developed a soft rot about the core or wilted and remained firm but insipid. In the 36° F. room, however, similar specimens gradually ripened and, except for a slight wilting, remained in marketable condition for nearly four months.

[7] Report of the College of Agriculture and Agricultural Experiment Station, University of California, 1921–22, p. 129.

Pear Scald in Cold Storage.—Preliminary studies of the development of pear scald in cold storage have been made by E. L. Overholser and L. P. Latimer. Pear scald results in a dark brown or blackened condition of the skin, generally localized at first, but finally involving the entire surface of the fruit, rendering it unfit for the trade (fig. 100). The scald is usually superficial, rarely extending more than one-eighth of an inch beneath the surface. A peculiar, slightly fermented flavor usually accompanies the scald and can be detected before the tissues show any discoloration.

Observations of the behavior of pears in cold storage during the past five years show that scald occurred when they were kept at temperatures of 45° F., 36° F., 32° F., and 30° F. Fruit not placed in cold storage, but ripened at room temperature did not develop scald; such fruit failed from internal break-

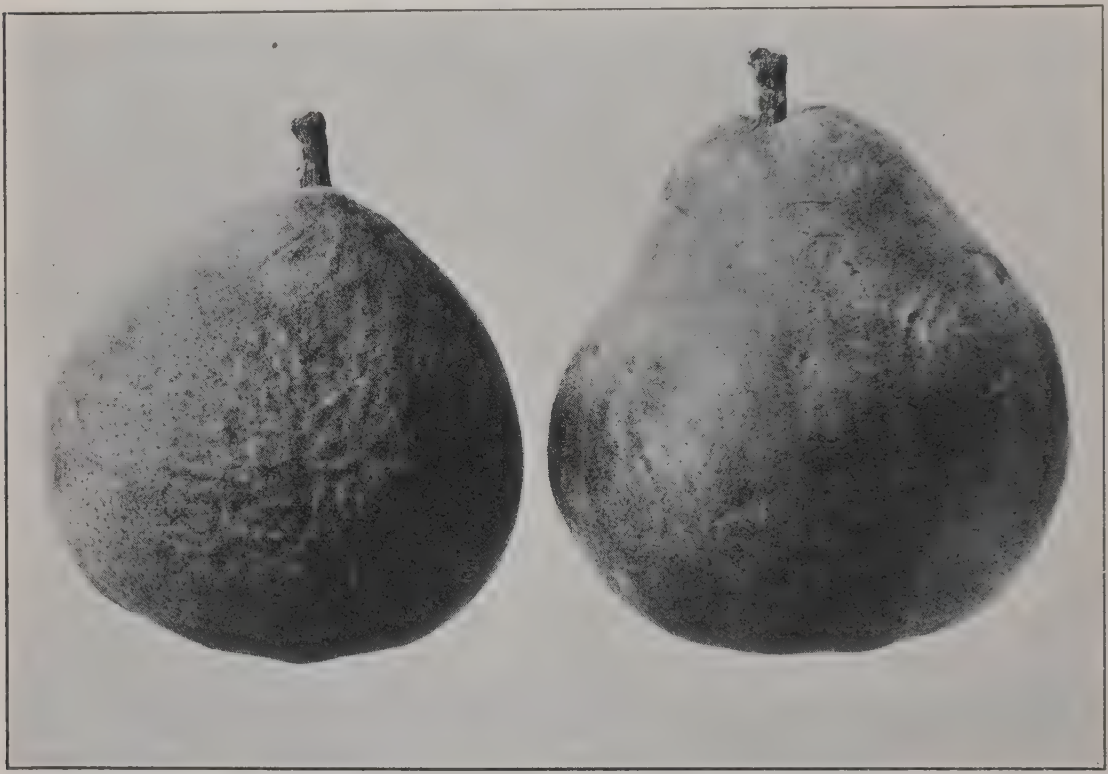


Fig. 98.—The specimen on the left is a Comice pear of the commercial picking (September 10); the one on the right is of the optimum picking (September 21). The photograph, taken January 15, illustrates the difference in size and amount of wilting at 32° F. storage.

down, wilt, or rot. Pears, however, stored at the higher temperatures of cold storage, especially 36° F., scalded more severely and at an earlier date than fruit of the same lot held at 32° F., and 30° F. A temperature of 32° F., as contrasted with 36°F., delayed the development of scald upon Comice pears from four to eight weeks and upon Bartlett pears about six weeks. At a temperature of 45° F., the quick germination of spores and the subsequent rapid growth of rot organisms resulted in decay before scald appeared.

With all varieties susceptible to scald, it was found that fruit harvested when properly matured was less subject to scald than that harvested when relatively green or overripe. The immature fruit generally scalded more quickly after harvest than did the properly matured fruit; over-mature fruit, however, scalded more rapidly and severely than either.

Data for four years show the Bartlett to be one of the varieties most susceptible to scald in storage. The Comice is next in susceptibility and is followed by the Louise and Clairgeau. The Bordeaux, Vicar, and Pound were also subject to scald in storage. The Easter Beurre, Forelle, P. Barry, and Anjou showed a marked immunity to scald.

Effect of Maturity at Harvest upon Pears in Cold Storage.—Studies of the effect of the degree of ripeness at harvest upon the keeping quality of pears in cold storage have been continued* by E. L. Overholser and L. P. Latimer. The varieties Hardy, Bose, and Comice, from the Santa Clara Valley were used. The fruit was picked at intervals from August 22 to October 3 and was stored at 32° F. and 36° F. The height of the commercial harvesting period conformed to the date of the second picking, September 1.

Fig. 99.—The specimen on the right is the first picking of Hardy made August 22, nine days previous to the commercial picking. The specimen on the left is from the optimum picking made September 21. Note the difference in size and degree of wilting. The first picking never became marketable.

The third picking of Bose pears made ten days later than the commercial picking in the Santa Clara Valley attained the most characteristic color, size, and general appearance, and exhibited the latest optimum and maximum date in storage.

The Comice pears of the fourth picking made eleven days after the height of the commercial harvest period, were most satisfactory for storage, as indicated by the following characteristics: (1) A maximum weight and a size

* Report of the College of Agriculture and Agricultural Experiment Station, University of California, 1921-22, p. 130.

nearly double that attained at the time of the commercial picking; (2) excellent quality, sweet flavor, and fine, melting, juicy texture; (3) highly colored, attractive fruit that retained the desirable qualities for over five months in storage at 32° F. and remained marketable for over two weeks after becoming ripe, subsequent to removal from storage.

The fourth picking of the Hardy, made nearly three weeks later than in commercial practice, kept best in storage at both 32° F. and 36° F., the size and flavor being the best of all. The first and second pickings were made before the fruit was sufficiently mature for harvest, as evidenced by the severe wilting, small size, and inferior flavor. The fifth picking was made too late in the season for successful storage, as indicated by the rapidity of ripening, breaking down, and rotting.

Fig. 100.—Clapp Favorite pear showing appearance of scald.

The evidence shows that immature pears do not keep as well as firm, mature specimens. Three seasons' observations indicate a tendency in many sections of California to pick pears before they are sufficiently mature. The texture, flavor, quality, and market value of this immature fruit does not equal that of the better developed, properly matured fruit. The fruit, however, must not remain on the tree long enough to become overripe. Such fruit is nearer the end of its life limit and consequently deteriorates with even greater rapidity in cold storage than immature fruit.

It is difficult, however, to give directions that will enable a grower to determine satisfactorily the proper time each season to harvest his pear crop, although the shade of the ''ground'' color is indicative. The ''ground'' color of pears, which is a deep green when the fruit is immature, becomes lighter in

shade and assumes a faint yellowish tinge as the fruit approaches maturity. A pronounced yellow, however, usually indicates over-maturity.

Blue Mold upon Pears in Storage.—The blue mold, *Penicillium expansum* (Link), has been the mold causing the greatest damage to pears in cold storage. E. L. Overholser, and L. P. Latimer have noted that blue mold has occurred at temperatures of 36° F. and higher. At temperatures of 30° F. and 32° F., however, the germination of the blue mold spores and the growth and development of the mycelium were so retarded that injury to pears was limited. Considerable damage resulted to pears stored at 36° F. and at 45° F.

The late pickings of pears were generally more susceptible to blue mold than earlier pickings. The occurrence of mold may have been lessened in the immature fruit by the lack of favorable moisture conditions.

Fig. 101.—Easter pears, showing characteristic type of failure in storage at 36° F. from blue mold *Penicilium expansum* (Link).

Wounds and bruises seriously increased the damage from *Penicillium sps.* Most varieties possessing a tough, well cutinized epidermis, free from bruises or abrasions, were rarely destroyed by mold in storage. Specimens of the same varieties, however, with skin punctures developed blue mold. In addition, the developing rot and exuding juice produced conditions so favorable for mold growth that adjacent sound fruits also became infected. Delay in storing after harvest greatly increased the susceptibility of pears to blue mold.

The varieties determined as most susceptible to the attacks of blue mold were the Onondaga, Flemish, Dix, and Easter Beurre. The varieties that appeared most immune to the disease were Columbia, Alencon, and Seckel.

Effect of Ammonia Fumes upon Pears in Cold Storage.—Anhydrous ammonia is the gas most frequently employed to obtain refrigeration. Notwithstanding

care exercised by those in charge of plants, leaks may occur in certain types of plants and ammonia fumes unavoidably gain entrance to storage rooms. E. L. Overholser and L. P. Latimer have noted the effect of ammonia gas upon the fruit.

Pears contain a substance that becomes dark when alkaline and colorless when acid. Ammonia gas gives an alkaline reaction, and since the fumes are quite soluble in fruit juices, they may be absorbed through the lenticel-like opening or ''dots'' of the epidermis sufficiently to bring about an alkaline condition in local areas.

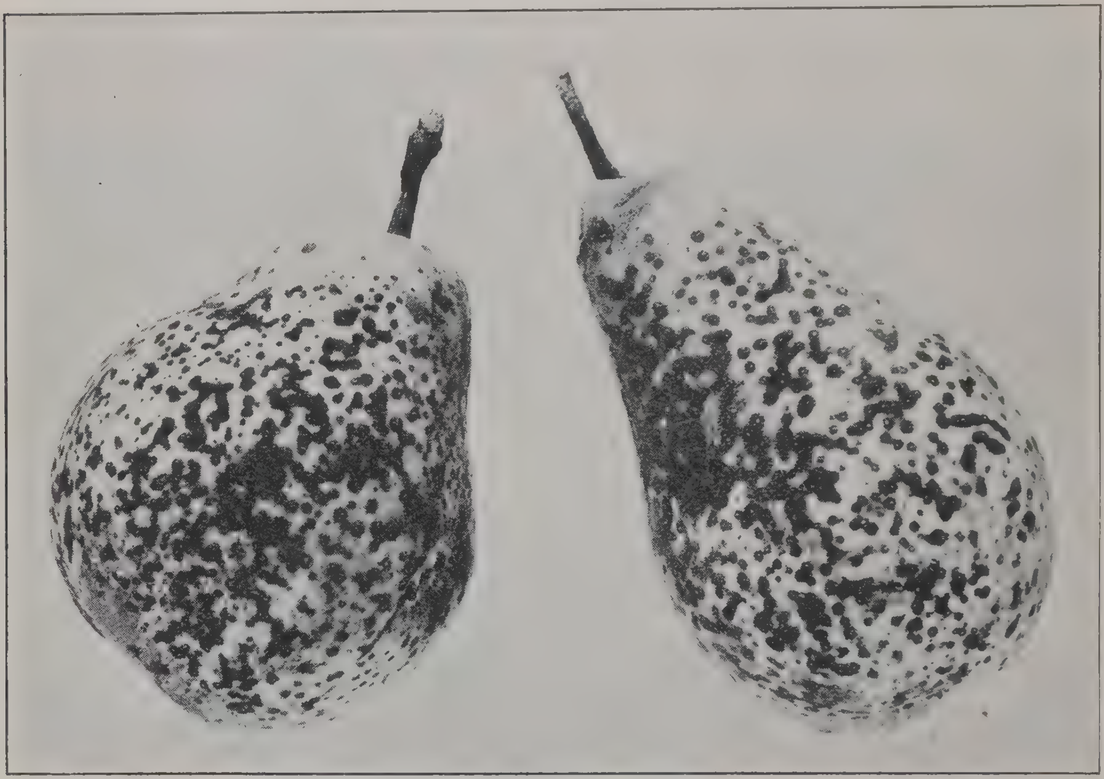


Fig. 102.—Vicar pear on left and Col. Wilder on right showing the effect of ammonia fumes upon firm unripe fruit.

The oxidation processes in pears also proceed more rapidly in a slightly alkaline medium than in the acid tissues of the fruit. Furthermore, the concentration of ammonia may become sufficiently great to act deleteriously by increasing the permeability of the cells and thus disorganizing the protoplasm and permitting the mixing of the oxidizing enzyme and substrate. Hence, fruit subjected to ammonia gas or fumes may also darken by oxidation, but the discoloration thus produced is apparently distinct from that effected immediately by alkalinity. The two colors, however, are inseparable upon the basis of appearance.

Figure 102 shows the characteristic appearance of pears subjected to ammonia gas. The cells immediately adjacent to the lenticel-like openings exhibited crimson colored rings which quickly became black. The depth of penetration, except upon prolonged exposure, was from three to five layers of cells. Upon continued exposure for from five to seven days, darkening took place to a depth of half an inch and the fibro-vascular bundles were darkened to a greater depth.

The presence of moisture increased the seriousness of the effects of ammonia fumes. Pears with a dry surface were not so susceptible to ammonia fumes as those with a moist surface. Pears picked in a green condition were more seriously affected by ammonia fumes than those picked in a more ripened state. There also appeared to be varietal differences. For example, the Hardy permitted the penetration of the ammonia fumes, with a resulting darkening four times as rapidly as that of the Comice.

Cold Storage of Plums. Further experiments* upon the behavior of plums in cold storage conducted by E. H. Rawl, under the direction of E. L. Overholser, emphasize the fact that for plums picked at the proper stage of maturity, 32° F. is the best storage temperature. For example, the President kept two weeks longer at 32° F. than at 36° F. At temperatures of 36° F. and 45° F. the failure of plums in storage was largely caused by the growth of molds. The two fungi chiefly responsible for the decay were *Botrytis cinerea* and *Penicillium expansum* (fig. 101). It was determined that the President and Eldorado were camparable to the Kelsey and Grand Duke in keeping qualities under cold storage conditions, all of these varieties remaining marketable at 32° F. for over eleven weeks.

Studies indicated a tendency on the part of the plum grower to pick plums prematurely with the result that the desirable, attractive appearance and high eating quality were never developed. A delay of three or four days permitted these characteristics to be attained without appreciably shortening the keeping period.

There was a gradual increase in the sugar content of each succeeding picking and this materially improved the flavor of the fruit. The sugar content of the President picked August 12 was 11 per cent; that of the pickings made August 19, 12 per cent; and that made August 28, 17 per cent. It is, however, unwise to permit the fruit to become overripe before harvest, since it more quickly deteriorates than immature fruit, especially at the higher temperatures.

Survey of the Dried Fruit Industry of California.—The following summary and brief conclusions are derived from a survey of the dried fruit industry of the State made in 1921 by L. C. Barnard and A. W. Christie of the Division of Viticulture and Fruit Products.

Apricots

1.	Ratio of dry yard acreage to bearing acreage	1 to 20
2.	Ratio of bearing acres to pickers needed	2 to 1
	(Number of times fruit is picked, 2 to 3)	
3.	Average pounds per picker per day	1675
	(Range 1000–2500)	
4.	Average cost of picking per ton	$3.00 to $3.50
	(Scales—$3.00 ton; 35 cents hour or 10 to 15 cents per box)	
5.	Average ratio cutters to pickers	2 to 1
	Average ratio cutters to bearing acreage	1 to 1
6.	Average pounds per cutter per day	650
7.	Average cost of cutting per ton	$6.75
	(Range $5 to $8 per ton or 10 cents to 20 cents per 50 lb. lug)	
8.	Ratio of dry yard men to bearing acreage	1 to 10
	Ratio of dry yard men to cutters	1 to 8.2
9.	Average cost of dry yard men per ton	$1.12
	(Basis $3.00 per 9½ hours a day)	
10.	Ratio of teams or trucks to bearing acreage	1 to 50 or less
11.	Ratio of sulfur houses to bearing acreage	1 to 4

* Report of the College of Agriculture and Agricultural Experiment Station, University of California, 1920–21, p. 65.

12. Square feet of tray surface per bearing acre........ 1150
 (Equivalent of 191 trays, each 2 ft. by 3 ft.; 64 trays, 3 ft. by 6 ft., or 48 trays, 3 ft. by 8 ft.)
 (Equivalent to one sq. ft. per 2 lbs. fruit per season or tray used only once in season)
13. Average daily capacity of sulfur house .... 2240 lbs.
 (Equivalent to 2 trucks of 20 to 25 trays, 3 ft. by 8 ft.)
14. Average pounds of sulfur per green ton (range 4 to 16)........ 6.4 lbs.
15. Average cost of sulfur per green ton........ 20 cents
16. Average time of sulfuring (range 3 to 12)........ 4½ hours
17. Average green yield per acre (range 3 to 9)........ 5.75 tons
18. Average drying ratio........ 5.4 to 1
19. Average dry yield per acre........ 1.07 tons
20. Average estimated cost of drying per green ton........ $16.47

Peaches

1. Ratio of dry yard areage to bearing acreage (range—1 : 10 to 1 : 20)........ 1 to 20
2. Ratio of bearing acres to pickers needed........ 4 to 1
 (Number times fruit picked, 3)
3. Average pounds per picker per day (range 2000 to 4000 pounds)........ 3000 lbs.
4. Average cost of picking per ton (40 cents per hour)........ $3.33
5. Average ratio cutters to pickers........ 5 to 1
6. Average ratio cutters to bearing acres........ 1¼ to 1
7. Average pounds per cutter per day (1000 to 2000 pounds)........ 1500
8. Average cost of cutting per ton........ $3.34
9. Ratio of dry yard men to bearing acreage........ } Insufficient data for drawing conclusions.
10. Ratio of dry yard men to cutters........ }
11. Average cost of dry yard men per ton........ }
12. Ratio of teams or trucks to bearing acreage........ }
13. Ratio of sulfur houses to bearing acreage........ 1 to 4
14. Square feet of tray surface per bearing acre........ 2000 lbs.
 (Equal to 331 trays, 2 ft. by 3 ft.; 100 trays, 3 ft. by 6 ft.)
15. Average daily capacity of sulfur house........ 3280 lbs.
 (Equal to 3 trucks of 20 trays, 3 ft. by 6 ft.)
16. Average pounds sulfur per green ton (range 4 to 12)........ 8.3 lbs.
17. Average cost of sulfur per green ton........ 25 cents
18. Average time of sulfuring (range 4 to 12)........ 6 hours
19. Average green yield per acre (range 4 to 19)........ 13 tons
20. Average drying ratio........ { Muir 4 : 1 to 4½ to 1; Lovell 4 : 1; Elberta 6 : 1
21 Average dry yield per acre........ 2.3 tons
22. Average estimated cost of drying per green ton........ $13
 (Range $10 to $16)

Prunes

1. Ratio dry yard acreage to bearing acreage (range 1 : 10 to 1 : 40)........ 1 to 20
2. Ratio of bearing acres to pickers needed (number times picked, 4........ 5 to 1
3 Average pounds per picker per day (range 1600 to 2000 pounds)........ 1800 lbs.
4. Average cost of picking per ton........ $4
5. Average pounds per dipping crew man per day........ 6800 lbs.
6. Ratio of dry-yard men to bearing orchard........ 1 to 2.7
7. Average cost of dry yard men per ton (range $.66 to $1.55)........ 1.14
8. Ratio of teams or trucks to bearing acreage (range 1 : 50 to 1 : 100)........ 1 to 72
9. Square feet of tray surface per bearing acre........ 2780 sq. ft.
 (Equal to 116 trays, each 3 ft. by 8 ft.)
10. Average green yield per acre (range 3 to 7)........ 5 tons
11. Average drying ratio........ 2.4 to 1
12 Average dry yield per acre........ 2 tons
13. Average estimated cost of drying per green ton........ { $5 to $6 (not including harvesting cost.
14. Cost of extra help per green ton........ $ .34
15. Average strength of lye dip (range 1 : 16 to 1 : 30)........ 1 lb. to 20 gals.
16. Average temperature of lye dip........ 200° F.
17. Average time of lye dip (range 15 to 60 seconds)........ 30 sec.

Frost Protection in Apricots.—Owing to the widespread use of heaters in apricot orchards in the Santa Clara Valley, continued studies were made by A. H. Hendrickson* on the use of these devices. There were no serious frosts in the orchards under observation, and although the results secured were largely negative, several interesting points were observed. Thermographs mounted on towers fifteen feet above the surface of the ground, showed that on quiet nights the temperature at that height was usually from two to four degrees higher than at five feet above the surface. This observation helps to account for the fact that the crop may be entirely destroyed on the lower parts of large trees, while the upper branches produce a normal crop. When the heaters, which were of the lard pail type, were lighted, the thermographs at the fifteen foot elevation showed a rise in temperature nearly as great as those only five feet above the ground, showing that the tops of large trees are benefited by the small fires close to the ground.

Fruit-bud Formation and Development.—C. B. Wiggans, working under the direction of W. P. Tufts finds that:

1. Pear fruit-buds begin to differentiate at approximately the same date (in 1922, first week of July), under coastal valley, interior valley, and foothill conditions.

2. Apricot fruit buds begin to differentiate at approximately the same date (in 1922, from August 10 to 15), under coastal valley, interior valley, and foothill conditions.

3. The altitude of the foothills seems to have a retarding influence on fruit-bud development, delaying the differentiation until the middle of September when development becomes quite rapid.

4. The humid coastal influence apparently stimulates rapid development of pear buds after differentiation. This is not the case with apricots until October, when development becomes extremely rapid and the buds go into the winter at a stage more advanced than is found under either interior valley or foothill conditions.

5. The dry, hot, interior valley appears to induce a steady uniform development of both pear and apricot fruit buds; however, these do not reach the advanced stage of development by early winter that buds from the coastal valley and foothills attain.

6. The inception of fruit-bud differentiation seemingly is not influenced to any extent by either heavy or light dormant pruning. Light pruning perhaps tends to induce a slightly more rapid development for six to eight weeks following fruit-bud differentiation of the pear.

7. Irrigation shows a tendency to retard fruit-bud differentiation and development.

8. Environmental conditions during winter as found in the principal fruit growing districts of California apparently do not exert a checking influence upon the fruit-bud development of the pear and apricot.

Irrigation of Prunes and Peaches.—Statistical data have been kept by A. H. Hendrickson on a block of 105 prune trees at the University Farm, Davis, for three years, and on 750 Muir peach trees at Delhi for two years. Through the use of these data the coefficient of variability was calculated for each block as a whole and for the separate plots in each block which are to be given diffe-

* Report of the College of Agriculture and Agricultural Experiment Station, University of California, 1921–22, p. 132.

ential treatment. By this method it was possible to secure a representative grouping of the duplicate and triplicate plots in order to reduce the error due to differences in soil. It also gives a starting point from which to judge any differences which may be secured when differential treatment is applied. The prune block at Davis was laid out to give data on four treatments, including checks in duplicate, while the Muir peach orchard at Delhi was laid out to give eight treatments, including checks in triplicate.

Transpiration Studies with Prunes.—In connecton wth the potometer studies with prune trees at Mountain View, F. J. Veihmeyer and A. H. Hendrickson showed an interesting relation exists between the amount of water used during the growing season and the total leaf area of the tree. The leaf area, total new growth and the amount of water used by thirteen trees in potometers were carefully measured. Some of the trees had been allowed to wilt at frequent intervals, but not allowed to remain in a wilted condition for more than three or four days at a time, while others were kept continually moist throughout the season. The ratios of water loss to leaf area, and water loss to new length growth were remarkably uniform. Likewise the coefficients of correlation of water loss to leaf area, and water loss to new length growth were exceptionally high, nearly approaching unity with a very small probable error.

Peach Twig-Borer.—Further experiments for the control of the peach twig-borer,* (*Anarsia lineatella* Zell), were conducted by G. J. Gerson and R E. Stanton under the supervision of W. P. Duruz. The results of these experiments correspond closely with data obtained during the two previous seasons: namely, that the additon of arsenate of lead to the lime-sulfur spray resulted in greatly increased efficiency. Arsenate of lead was superior to lime-sulfur in controlling this insect. Nicotine sulfate did not give as high control this year as it gave during the two previous seasons.

Control of Pear Blight Canker.—Experiments designed to arrest the development of infections of pear blight (*B. amylovorus*) in the larger branches of the trees, were continued by L. H. Day.† Definite success was achieved in the scarification process. Control by this method was found to depend upon,

(*a*) the thoroughness in which the outer bark was pared away;
(*b*) paring nearly to the cambium in bark thickening in crotches and old scars;
(*c*) operating before the cambium is injured extensively by the disease.

Cyanid of mercury and bichlorid of mercury, one part of each by weight to 500 parts of a solvent consisting of three parts glycerine and one part water, gave very good results. Several orchardists to whom this formula was given secured from 80 to 90 per cent control by this method, while careful scarification carried out by G. J. Gerson, a student, working under the direction of L. H. Day, secured 100 per cent control as against 20 per cent control without disinfectants and 33 per cent control with cyanid and bichlorid of mercury, one part each to 500 parts of water by weight. During the spring of 1923, many orchardists used scarification with the glycerine formula, and reports to date indicate quite satisfactory results. Carelessness and lack of understanding of

* Report of the College of Agriculture and Agricultural Experiment Station, University of California, 1921–22, p. 134.

† Report of the College of Agriculture and Agricultural Experiment Station, University of California, 1921–22, p. 132.

the nature of the disease on the part of the operators militate against complete success in extensive orchard operations. The advantage of the disinfectant formula containing glycerine lies in its non-drying qualities which permit it gradually to penetrate into the diseased tissues after the outer bark is pared away. It sticks to the shears and tools for a long time and also probably prevents any immediate reinfection of the wounds by insects. Its chief fault lies in its inability to penetrate laterally under the outer bark and inwardly through the extra thick portions of bark.

Several other disinfectants were tried. The most promising of these consists of a 1½ per cent potassium iodide solution, plus 1 per cent iodine in denatured alcohol. Though this has not been used long enough to warrant definite conclusions, its relatively non-caustic properties and its deep penetration into bark thickenings as well as its lateral penetration under patches of bark left in the diseased area, indicate that it may be much superior to all others yet tried.

Preliminary experiments in culture tubes by A. G. Plakidas, a University student working under the direction of L. H. Day, indicate that the pear blight organism is very sensitive to iodine.

The California Pear Growers' Association rented the G. F. Otis pear orchard at Marysville for the use of the College of Agriculture in experiments in pear blight control during 1923.

Experiments in the use of disinfectants and chemicals "painted" over cankers without previous surgery to arrest the development of the disease have been continued throughout the year. Several materials were found that will stop the progress of the disease, but the difficulty experienced with most of them was to find a concentration that would penetrate to the bacteria in the healthy bark at the advancing margins of the canker and yet not over-penetrate and injure the cambium in the older parts of the canker. Zinc chlorid, iodine, and iodine compounds are the most promising. These have been tried at various concentrations and in several combinations. The experiments have not been continued long enough to warrant positive conclusions.

It has been found that under different conditions trees vary in the degree of absorption of chemicals and disinfectants.

Zinc chlorid has been under trial for almost a year. A solution consisting of one pound zinc chlorid crystals dissolved in one pound of a solution consisting of 95 per cent denatured alcohol and 5 per cent concentrated hydrochloric acid, and then the whole made into a thin paste by the addition of 3.2 ounces of powdered infusorial earth has given best results. It can be used successfully only on new cankers on branches over one inch in diameter and is not uniformly successful on trunks and larger scaffolds which have developed a scaly outer bark. To avoid penetration into the sap wood, the bark should not be broken or punctured nor should small branches be cut closely within the area to be treated. Notwithstanding its limitations, several growers are using zinc chlorid in preference to the more laborious surgical operations involved in shaving off the bark preparatory to using the cyanid bichlorid disinfectants. If the grower would go over the orchard at intervals of ten days or two weeks, he could find most of the cankers before they get too old to treat. However, we are not yet ready to advise growers to use zinc chlorid.

Iodine is the most promising in that it is not so caustic as the others and will not seriously injure the cambium nor travel in the sapwood as readily as zinc chlorid. Iodine penetrates so slowly through the waxy covering of the bark that it has been found necessary to combine it with other materials in

order to get it quickly into the bark. A combination consisting of zinc chlorid and iodine in denatured alcohol, in experiments now under way, seems to avoid the over-penetration into the old parts of cankers experienced with the heavier concentrations required in the case of zinc chlorid and of the iodine salts.

Planting Distances for Deciduous Fruit Trees.—F. W. Allen reports that peach trees planted 12 and 16 feet apart in 1915 and thinned in 1920 to 24 by 24 and 32 by 16 feet were so weakened by the crowding as to be unable to respond to the thinning. Decrease in general vitality has been accompanied by rather severe attacks of peach blight, a general dying back of the new wood, and a sun-burning of the main branches. Several trees in each block are dead, and those remaining are of little value. The apricot trees show the same general condition although to a less extent.

French prunes, Climax plums, and Royal Ann cherries planted 12 by 12 feet were thinned to 24 by 24 feet just before the 1923 growing season. The prunes and cherries have apparently withstood the crowding without any evil effects except a general dwarfing of the trees. Several trees of each fruit have been lost by gummosis and other troubles. Lack of sufficient soil moisture for trees planted closer than 20 feet was shown last September by premature coloring and dropping of the foliage.

Fruit yields of Climax plums, Royal apricots, and Elberta peaches for 1922 show that the plums planted 12 by 12 feet produced at the rate of 11,476 pounds to the acre, while the trees planted at 24 and 30 feet apart each produced on the average approximately 8000 pounds to the acre. Since the original 12 by 12 foot planting (Block A) has been thinned to a distance of 24 by 24 feet, making the trees stand the same distance apart as those planted in Block D, a definite comparison of yields can be made during the present season.

Apricots in Block A, thinned to 24 by 24 feet before the 1922 crop, yielded 59 pounds of fruit to the tree or only 1416 pounds to the acre as compared with 136.5 pounds to the tree, or 10,237.5 pounds to the acre, from trees in Block D originally planted at 24 feet. Elberta peaches under the same conditions produced no fruit in Block A, while the yield from Block D was 278 pounds to the tree or 20,850 pounds to the acre. Yields from Bartlett pears, French prunes, and Pond plums were too small to allow any very definite comparisons.

Almond Pollination.—W. P. Tufts and G. L. Philp report the Eureka variety as self-sterile, thus adding another commercial variety to the long list of self-sterile sorts—no commercial variety as yet tested having proved to be self-fertile. Ne Plus Ultra and Nonpareil are satisfactory pollinizers for the Eureka.

Preliminary studies with certain new seedlings originated by the same workers, apparently give promise that self-fertile varieties of high commercial value may yet be secured.

Apple Pollination.—Data for 1923 upon pollination requirements of apples in Sonoma County substantiate previous observations. In addition, E. H. Rawl, under the direction of E. L. Overholser found that the Yellow Newtown and Delicious pollinated the Yellow Bellflower. The Baldwin proved to be self-fertile.

Sterility of Sweet Cherries.—Preliminary experiments by W. P. Duruz show that the non-setting of fruit in cherries is partially due to the influence of secretions in the pistil on the germination of the pollen grain and on the length of pollen tube growth. Black Tartarian, Black Republican, and Napoleon were the varieties tested. The percentage of artificial germination of each variety was increased by the addition to the growing medium of decoctions consisting

of parts of pistils of another variety. The length of pollen tube growth was likewise remarkably increased when a decoction of the stigma, style, or ovary of another variety was added to the medium.

Decoctions made from the Napoleon ovary gave a higher percentage of germination of Black Tartarian pollen than did decoctions made from the stigma or style. Decoctions from the stigma were slightly better than those of the style in increasing the percentage of germination. On the other hand, decoctions from Black Tartarian stigma, style, and ovary were slightly toxic to the germination of Black Tartarian pollen. Similar observations were made using Black Republican and Napoleon pollen.

The length of pollen tubes in the various decoctions was also noticeably influenced. For example, Black Tartarian pollen tubes reached a length of 49 microns in a decoction of Napoleon stigmas and only 13 microns in a decoction of its own stigmas. This seems to show that there is present in this variety some substance which retards the growth of its own pollen tube. Similar data were secured with the other three varieties mentioned.

Cytological examination has shown that the pollen of self-sterile varieties of sweet cherries is not aborted. Many sections have been made of cherry buds in successive stages of development. These indicate the fact that pollen is formed in a normal manner. Artificial germination in sugar solution shows that the pollen is viable, although, when placed upon its own stigma, it does not result in fruitfulness. Further experiments are necessary in order to determine more definitely the underlying causes of sterility.

Pear Pollination.—Further studies by W. P. Tufts and G. L. Philp* show that pear varieties as grown under Sacramento Valley conditions vary in their pollination requirements. During the 1923 season, certain varieties grouped themselves into three classes:

1. Self-fertile to a marked degree: Easter, Dana Hovey, and Seckel.
2. Self-fertile to a limited degree and greatly benefited by cross-pollination: Clairgeau, Clapp Favorite, Comice, Colonel Wilder, and Patrick Barry.
3. Self-sterile to a marked degree: Bartlett, Kieffer, and Winter Nelis.

Under foothill conditions at 3000 feet elevation in Nevada County, the following results were obtained:

All the varieties tested, Bartlett, Bosc, Comice, and Winter Nelis, proved to be self-sterile.

The Bosc, Comice, and Winter Nelis proved to be satisfactory pollinizers for the Bartlett, which in turn was a good pollinizer in the reciprocal crosses.

The Winter Nelis proved to be a good pollinizer for the Bosc and Comice.

The Comice and Bosc were satisfactory pollinizers for Winter Nelis.

It is interesting to note that the Winter Nelis, which has been tested for self-sterility for four years, has in all cases failed to set fruit when self-pollinated. These tests were made under Sacramento Valley, foothill, and coastal conditions.

Pollination of Plums.—Studies on the pollination of plums were continued by A. H. Hendrickson† to establish the sterility status of varieties upon which

* Report of the College of Agriculture and Agricultural Experiment Station, University of California, 1921–22, p. 128.

† Report of the College of Agriculture and Agricultural Experiment Station, University of California, 1921–22, p. 127.

there were no data. The Jefferson, a variety used in canning, was found to be partially self-fertile and very effectively pollinated by the Sugar. The Coates 1418 prune was likewise found to be partially self-fertile and effectively cross-pollinated by the French, Sugar, and Imperial. The reciprocal crosses of this combination were also successful, indicating that these four varieties may be safely interplanted for purposes of cross-pollination. The weather during the blossoming season in the Santa Clara Valley was unusually warm, reaching a maximum of 85° F. on March 27. The resulting crop which set was very light.

Pruning Young Almond Trees.—The almond pruning experiment being carried on by C. L. Austin* continues to show marked differences in development between the short and long pruned trees. Trunk circumferences have been used as a measure of total tree development. The average trunk circumference of five-year-old almond trees was found to be 48.6 cm. as compared with 40.6 cm. for those thinned and headed lightly, and 34 cm. for those thinned and headed severely. The most marked difference was noted in the case of seedlings with an average trunk circumference of 63.2 cm. for trees thinned out only and 35.2 cm. for those thinned and headed severely. These figures indicate that the development has consistently been inversely proportional to the severity of the pruning.

When only four years old, the trees that had been thinned out, averaged 4 pounds of hulled nuts, while those that were thinned and headed severely (short pruned), yielded only 0.3 of a pound. The thinned and lightly headed trees gave an intermediate yield of 1.7 pound.

Influence of Pruning upon Top and Root Development.—In order to determine the effect of pruning upon top and root development, a series of studies have been carried on by C. L. Austin with young almond trees. Experiments in which 11 three-year-old Nonpareil almond trees were dug up, the tops and roots weighed and measured, show very conclusively that the development of both the top and the root system has been indirectly proportional to the severity of the pruning. The average weight of tops of trees thinned out only was 39.5 lbs. as compared with 19.7 lbs. for those thinned and headed severely. Similarly, the average weight of roots was 32.5 lbs. for those thinned out only and 16.9 lbs. for those thinned and headed severely, while the spread of roots was 15.5 ft. and 9.8 ft., respectively.

Influence of Pruning Upon the Total Amount of New Growth.—It is generally recognized that the new growth resulting from "long pruning" is much shorter than that following "short pruning," but since the shoots on the former are generally more numerous, the question may well be raised as to which type of pruning results in the greatest total amount of new growth. In order to aid in answering this question, C. L. Austin has measured all the new growth on eight almond trees that have been pruned in different ways. The work was done on five-year-old Nonpareil almonds and on six-year-old Texas almonds, both growing at Winters without irrigation.

The results with the Nonpareil show that the "short pruned" trees made over twice the amount of new growth that was produced on the "long pruned" trees, while in the case of the Texas, the "short pruned" trees put forth about four times as much new growth. These trees would be classed as bearing trees, and quite different results might be expected if measurements were made on

* Report of the College of Agriculture and Agricultural Experiment Station, University of California, 1921–22, p. 126.

young non-bearing trees, or on young bearing trees that had received adequate irrigation.

Bringing an Apricot Orchard into Bearing.—This experiment, which was started by W. P. Tufts and is being continued by C. L. Austin, deals with five distinct pruning treatments. The most interesting comparison being made is that between the so-called "long pruning" and "short pruning," the yield records for each of the years having been kept. The average total yield for the "long pruned" trees has been 313.8 pounds, as compared with 25 pounds for the "short pruned" trees. Moreover, the "long pruned" trees have come into bearing about two years earlier than those "short pruned."

Other trees in this experiment have been pruned by thinning out and cutting back lightly, a treatment intermediate between the two just considered. The yields have been much greater than those on the "short pruned" trees, but generally somewhat less than those on the "long pruned" trees.

The two other treatments in this experiment were early and late summer pruning. Early summer pruning in addition to a light winter pruning did not increase the yields as has been claimed by some growers, but somewhat decreased them. Late summer pruning materially reduced the yields during the first three years.

Influence of Pruning upon Leaf Area.—This work was carried on by C. L. Austin to determine the comparative leaf area at differen periods during the growing season on five-year-old apricot trees that had been "long pruned" and on those that had been "short pruned."

In order to obtain the leaf area of a tree, it is first necessary to count the number of leaves on the tree, and then find the average area of each leaf by the use of a planimeter. The product of these two figures gives the total leaf surface in square inches.

Two trees of each pruning treatment were counted, and the leaf area computed during the first week each of April, May, and October. The average leaf area of the "long pruned" trees at the April count was 50,453 square inches, while that of the "short pruned" trees was only 21,933 square inches. At the May count the "long" and "short pruned" trees showed leaf areas of 80,820 and 74,546 square inches, respectively. The October count showed the "short pruned" trees to be slightly ahead, the average leaf areas being 292,247 and 300,684 square inches.

It will be noted that the "long pruned" trees had a much greater leaf area during the early part of the growing season when the fruit was setting and sizing up. While the leaf areas were nearly the same during the middle of the season, it must be considered that the "short pruned" trees were at this time utilizing a large part of the plant foot elaborated by their leaves in making luxuriant wood growth, instead of devoting it to the development of the fruit and fruit-buds.

Comparative Study of the Gross Morphology of Headed and Non-headed Trees of Pear and Apricot.—A comprehensive study by S. H. Cameron, working under the direction of W. P. Tufts, of current season's shoots, mature wood up to six years of age, and young spurs of headed and non-headed trees of pear and apricot from May 15, 1922, to April 15, 1923, showed the following results:

1. On headed trees the shoots of the current season were greater in diameter, were stockier, and had a much greater total length growth than corresponding shoots on non-headed trees.

2. They had, during the early part of the season, a much greater total leaf area to the average shoot, but less to the length unit (inch) than corresponding shoots on non-headed trees. Toward the end of the growing season the leaf area to the unit of length was the same for shoots of both types of tree, although the total leaf area to the shoot was very much greater on shoots of headed trees than on shoots of non-headed trees.

3. The leaves of shoots of the current season on headed trees contained more water throughout the season than leaves of corresponding shoots on non-headed trees, but the shoots themselves showed no consistent difference in water content.

4. There was no appreciable difference in length of tracheal tubes or in water-conducting capacity of shoots of equal diameter from headed and non-headed trees.

5. The cells of the current season on headed and on non-headed trees showed no appreciable difference with respect to either size of cell or thickness of cell-wall during the early part of the growing season.

6. In mature shoots of the current season, the cells were larger and usually thicker walled on headed than on non-headed trees.

7. Shoots of the current season on headed trees contained a smaller proportion of pith and bark and a greater proportion of wood than corresponding shoots on non-headed trees. The wood of shoots on headed trees contained more strengthening but less storage tissue than the wood of shoots on non-headed trees.

8. There was a gradual fading out, with increasing age of the branch, of the differences exhibited by shoots of the current season on headed and on non-headed trees.

9. Length growth ceased much earlier in shoots of the current season on non-headed trees than on headed trees, but the terminal portion of the shoots on headed trees had time to ripen their tissues sufficiently for winter.

10. The terminal portion of shoots of the current season on headed trees greatly resembled in structure and appearance those on non-headed trees. Apparently the only difference was that the season of growth differed.

11. There was much variation in the size and in the structure of leaves on shoots of the current season on the same tree, but in general the leaves of shoots on headed trees were larger, thinner, and less compact in structure than those on non-headed trees.

12. The spurs of headed and of non-headed trees exhibited no consistent differences in external appearance or in structure. Spurs of non-headed trees blossomed earlier than those of headed trees.

13. There were two maxima and two minima for starch deposition in the young growth. The first maximum was in the latter part of September or the early part of October for the apricot and in the latter part of October for the pear. The second maximum was in the latter part of February and the early part of March. The first minimum was in May and the early part of June, and the second in the latter part of January and the early part of February.

14. Starch accumulation began earlier in the non-headed than in the headed trees, and starch disappeared from non-headed trees most rapidly in the spring.

15. In the pear, starch disappeared first from the bark and then from the wood parenchyma, the medullary rays, and the pith in the order named. In the apricot, disappearance was in the following order: pith, wood parenchyma, bark, and medullary rays.

16. Starch disappeared first from the tips of one-year-old shoots and then progressively downward to the older branches.

Studies in Securing a Broad Base for Fruit Trees.—Preliminary tests conducted by C. L. Austin indicate that it is a comparatively simple matter to spread the scaffold limbs of upright growing varieties in order to form a somewhat broader base for the tree. The method consists in selecting three scaffold limbs during the first summer's growth in the orchard, or at the time of the first winter pruning, and tying them down to clods or stakes. If the shoots are long, it is probably best to cut them back moderately. The Bartlett pear trees that have been treated in this manner have a much better framework than those on which only the pruning shears have been used.

A New System of Tying Trees Down.—This new method of handling fruit trees has been tried by C. L. Austin on all the common deciduous fruits. The system originated with Mr. Caldwell of Camino, who has had marked success with it upon pear trees.

The method consists in bending over vigorous upright shoots to a little below the horizontal and tying them in that position with 4-ply cotton twine running from the outer part of the branches down to the trunk. The terminal part of the bent limb soon develops an abundance of fruit spurs, while vigorous shoots arise at the bend. The latter are tied down the following year, making a second "tier" of limbs above the first, as shown in figure 103.

Fig. 103.—A five-year-old Bartlett pear tree which has been tied down twice. Note the two series of bent limbs.

The system has not proved very successful on the almond, apricot, peach, or Japanese plum. In the case of the cherry, it was found to be practically impossible to keep the bent limbs down, the principal growth coming from the *ends* of the bent limbs. For this reason its chief value on cherry trees lies in giving more spread to the scaffold branches. The behavior of the prune is in striking contrast to that of the cherry, in that almost all of the growth goes into new shoots which arise at the *bend,* while the ends of the bent limbs develop short spurs. The pear responds in much the same way, although there is not quite such a great difference in the amount of growth which develops at the ends and at the bends. It is with this fruit that the system appears to work best of all. The response of the apple to bending is intermediate between that of the pear and cherry, and it is probable that the system will work quite well on this fruit.

The following are some of the advantages of the method which have developed from the tests conducted:

1. A great increase in spread and in bearing area, and the reduction of the height of the tree, thus admitting light and facilitating all orchard operations except harvesting.

2. Earlier bearing. Tied down pear trees will probably come into bearing about a year earlier than ''long pruned'' trees.

3. A heavy production of bearing trees.

4. The elimination of much of the waste caused by pruning, since comparatively little pruning is necessary with this system.

''Long Pruning'' Young Japanese Plums.—The possibilities of ''long pruning'' on young trees is well shown in the accompanying photographs (Figs. 104 *a–b*) of Wickson plum trees, which were taken by C. L. Austin at the Cutter Brothers' ranch near Sacramento.

The picture at the left shows a one-year-old tree. The three scaffolds were made to branch out by pinching back during the first summer. At the first winter pruning, two shoots were saved from each of the primary scaffolds. While the tree shows splendid development, it has the common fault of the three main limbs arising from one place on the trunk.

The photograph at the right shows the same tree when two years old, at which time it had reached a height of about 10 feet. The upright habit of growth is characteristic of this variety. Note the abundant bloom, which has resulted in a good set of fruit. This tree will probably yield at least eight pounds when only two years old.

Pruning Experiments with Young Japanese Plums.—A coöperative pruning experiment is being carried on by C. L. Austin at the Cutter Brothers' orchard near Sacramento. Three pruning treatments are being tried on three of the most important commercial varieties of Japanese shipping plums.

The first treatment consists of a thinning out process, or ''long pruning,'' while the second consists of a thinning out and severe heading or ''short pruning.'' The third treatment is intermediate between the other two.

The average yield of trees thinned out only was 21.8 pounds for the Climax, and 7.3 pounds for the Santa Rosa, while for that of trees thinned and headed severely the average yield was 13 pounds and 6 pounds, respectively, for the two varieties. The increased yield resulting from ''long pruning'' over that

obtained from "short pruning" was not accompanied by a decrease in the size of the fruit, which averaged about nine fruits to the pound for all treatments in the case of the Santa Rosa variety and seven to the pound in the case of the Climax variety.

a *b*

Fig. 104.—*a*. A one-year-old "long pruned" Wickson plum tree. Note splendid development and the fact that the tree already has six scaffold limbs. *b*. Same tree as in *a*, when two years old. Note abundant bloom.

Carbohydrate Storage in Pear Shoots.—Preliminary studies from September to March, inclusive, by W. P. Tufts on the storage of sugars (total and reducing), total polysaccharides, and starch in pear shoots borne by vigorously growing six-year-old Bartlett pear trees, reveal the interesting fact that the terminal portions of the shoots, during each of seven months in which tests were conducted, contained a greater concentration of the materials listed above than did the basal portions of the same shoots.

Light vs. Heavy Heading of New Shoots.—Experiments conducted by W. P. Tufts and C. L. Austin in which vigorous new shoots on prune and pear trees were cut back to different lengths clearly indicate that the stockiness, number of spurs, and length growth are all indirectly proportional to the severity of the cutting back. These points may all be clearly seen in figure 105. For example, French prunes cut back to 12 inches showed a diameter growth of 0.57 inch, an average of 4.7 spurs, and a total length growth of new shoots of 154 inches; those cut back to 24 inches, showed 0.74 inch diameter growth, an average of 9.4 spurs, and a total length growth of 230 inches; and those cut to 36 inches showed a diameter growth of 0.92 inch, 14.3 spurs, and a total length growth of 284 inches.

Study of the Rest Period of Deciduous Fruit Trees.—Working under the direction of J. P. Bennett, F. R. Hodgson, a graduate student, in a study of the rest-period of the flower and leaf buds of the more common deciduous fruit trees of California, has observed the following points:

1. Apricots, apples, cherries, peaches, pears, and plums (Japanese and European), for the most part, have a definite winter rest period.

2. This period varies among the different species and varieties and may last from sometime in summer or autumn until sometime between early and late winter.

3. Almonds have an uncertain rest period extending not later than November. A few varieties of pears and Japanese plums have a short and easily broken rest period which is, however, as uncertain as, and more extended than, that of almonds.

4. The more easily broken the resting condition, the sooner it disappears; the more intense it is, the later it appears to last.

5. Japanese plum varieties appear to have a short, easily broken rest period as compared with European plums.

6. Apple varieties have the most profound rest period of all the deciduous fruit trees studied.

7. There is no apparent relation between the rest period and the presence of leaves on the twigs.

8. Treatments with ether, warm water, freezing and thawing, injuring the bark immediately above or below the buds, and placing cut twigs in dilute sodium nitrate solutions are effective in breaking the rest period. Ether appears to give the most uniform results.

9. The breaking of the rest period is accompanied by the loss of starch in the buds. This occurs under conditions where growth probably can not take place and indicates that the stimulation of enzyme activity may be an important factor in the breaking of the rest period.

10. In no case where the rest period was artificially broken did the buds push out with normal growth.

Fig. 103.—Two French prune shoots, each two years old. A year before the picture was taken they were both the same length and diameter. The shoot at the left was cut back to one foot, while the other was not headed. Compare the resulting stockiness, number of fruit spurs, and total amount of new growth.

The Rest Period of Solanum tuberosum in Relation to Nitrogen.—Experimental evidence has been secured by W. Newton, a graduate student working under the direction of J. P. Bennett, upon the rest period of the potato tuber in relation to nitrogen. He finds that the growth of potato tubers planted during their rest period is retarded to a greater degree during their early growth phase by the absence of nitrate than when planted after the expiration of their rest period. Resting and non-resting tuber seed pieces of equal weight were planted in pure silica culture sand; one-half of each lot was supplied with a complete nutrient solution and the other half with a solution modified so as not to contain nitrate or any other source of nitrogen. The growth rate of the plants from resting tubers was strikingly increased by the presence of nitrate during the early growth phase while on the other hand the growth rate of the plants from the non-resting tubers was not significantly affected. Owing to the very slow growth of the plants from resting tubers, as compared with that of the plants from non-resting tubers in the absence of nitrates, the results suggest that the breaking of the rest period depends at least in part upon the internal nitrogen supply of the tubers. Further evidence upon this factor has been obtained from data which indicate that the activity of proteolytic enzymes is greater in the juice of non-resting tubers than in the juice of resting tubers. Through the use of peptone and casein as substrates, the largest increase of amino acid nitrogen upon incubation was obtained when the juice of non-resting tubers was added. Similar results were obtained by autolysis of potato juice. The data secured from tubers analyzed at intervals during the rest period suggest that there is an increase in both amino acid nitrogen and amid nitrogen during the rest period. The increase does not appear to be large and may easily be overlooked if the variability of the sample is not considered. In tubers of low dry matter content, the ratio of amino acid plus amid to total nitrogen is much lower than in the case of tubers of high dry matter content. This suggests that there is a carbohydrate, amino acid, and amid equilibrium that must be considered in a study of the rest period.

Type Selection for Myrobalan Seedlings.—It is a well known fact that there are a great many different types of Myrobalan plums, particularly as determined by fruit characters. Owing to the fact that this fruit has never been used for eating purposes in this country, the different types have not been given variety names.

The main interest in this fruit is for the production of seeds, as the Myrobalan is the chief rootstock for all plums and prunes. An effort is being made by W. L. Howard to select types for seed purposes. There are many questions involved and many special interests to be harmonized.

The seed collector desires to have trees that all ripen their fruit at the same time. He also prefers freestone types, and because fruit is bought by weight, he prefers small fruited types.

The nurseryman desires, first of all, types with a high percentage of germination and those that make somewhat upright growing trees rather than the horizontal-branched, thorny types. He also wishes to secure as great a number of seeds to the pound as possible, therefore types with small pits interest him.

The fruit grower wants all of his trees propagated on a uniformly vigorous growing type of Myrobalan, and he wishes to have some assurance that his trees not only will be uniformly vigorous, but will be long lived.

All these different ideas and interests are being taken into consideration in type selection experiments.

Resistant Peach Stocks.—A collection of pits of the Peento or saucer peach were planted by W. L. Howard in the spring of 1923. These are to be used as stocks for standard peach varieties which are to be tested out for resistance to nematodes. Inquiry in the Southern States where the nematode has been a grave problem for some time has brought forth the information that the Marianna plum promises to be a very reliable rootstock as regards freedom from nematode injury. A supply of this plum will be procured next winter.

Pear Stocks.—Several hundred pear trees were bench grafted by W. L. Howard by using long scions (9 inches to 10 inches) of Surprise and Old Home, and short crown roots (4 inches long) of French pear seedlings. It is hoped to force the varieties to form roots of their own, when the French nurse roots may or may not be removed. The trees are to be top-worked to Bartlett after setting in the orchard. This plan would give trees with trunk and main branches that would be free from blight, as both the Surprise and Old Home are immune to this disease.

An effort was also made by J. J. Pierce, under the direction of W. L. Howard, to root hardwood cuttings of the Surprise and Old Home varieties. With the object of hastening or forcing the rooting, the cuttings were treated by dipping in very weak solutions of potassium permanganate, phosphoric acid, and cane sugar. The best results followed the use of a 0.1 per cent solution of the permanganate, while the 0.01 per cent solution of phosphoric acid treatment on Old Home pear cuttings seemed promising. The Old Home was more difficult to influence toward rooting than the Surprise.

Observations by W. L. Howard on the Japanese pear as a stock for Bartlett in numerous places throughout the state, indicate that the trees on this root soon become unhealthy and eventually die when planted in wet or sour soils. In the same soils trees on French root continue to thrive.

Armillaria Control.—One of the dangers in the use of concrete barriers as a protection against the spread of the oak root fungus is the tendency to place the barrier too close to the infected area. One of the prune trees thus protected on the Stockle ranch in the Santa Clara Valley died during the past season. Inspection showed that the disease had evidently started on one of the small roots extending toward the diseased area, and, although the trunk and main roots were healthy when the barrier was built, the tree died within two years. To be safe it seems necessary to place the barrier at least two rows beyond the diseased area.

All of the young prune trees treated with agricultural lime as a possible protection from oak root fungus died. Evidently the use of this material does not prevent the spread of this disease. Several additional *P. Davidiana* seedlings succumbed to this disease during the season.

The pear seedlings which, after three years in a diseased area, are still vigorous are *P. calleryana*, *P. betulaefolia*, *P. ba Li*, *P. serrulata*, *P. serotina* and *P. ussuriensis*.

Small Fruits.—Data have been secured by A. H. Hendrickson on the adaptation to conditions in the central coast section of California of a number of varieties of strawberries, raspberries, and blackberries, together with the cultural practices, diseases, and insect control, and methods of handling these fruits.

POULTRY HUSBANDRY

Feeding Value of Different Grades of Meatscrap.—Information in addition to that previously reported* on relation of protein content of feed to egg yield has been obtained by J. E. Dougherty.

Three lots of 32 hens each were fed three brands of meatscrap of varying protein content, ranging in cost from $60 to $136 the ton. Lot I received a basic ration plus 15 per cent of a 40–45 per cent crude protein meatscrap: lot II, the basic mash plus 15 per cent of a 50–55 per cent crude protein meatscrap; and lot III, the basic mash, plus 10.6 per cent of a 70–75 per cent crude protein meatscrap.

Lot II was fed the medium protein meatscrap most widely used by poultry keepers. Lot I received the same quantity of low protein scrap as lot II in order to determine whether it was equally as valuable in spite of its lesser protein content. Lot III was fed sufficiently less of the high protein scrap to make the amount of meatscrap protein equivalent to that in the mash fed to lot II.

The average egg production was practically the same in both the low and high protein meatscrap lots (133.8 and 134.5 eggs, respectively), whereas the hens receiving the medium protein scrap averaged approximately 10.5 fewer eggs to the hen. On the other hand, the medium protein pen (lot II) averaged as much feed to the hen as the high protein pen (lot III), and practically four pounds more than the low protein pen (lot I). In other words, the low protein lot laid as many eggs as the high protein lot and ate less mash than either of the other lots. Lot I, therefore, received the least protein for each dozen eggs produced.

The mortality was greatest in the low protein lot (lot I), being 25.7 per cent, and lowest in the high protein (lot III), being 10.7 per cent. This is somewhat difficult to understand in view of the fact that egg production in the low protein pen was high. If the low protein scrap were unhealthful, production should have been less, since health is recognized as fundamental to production.

The findings of this trial should not be considered conclusive until verified by further investigation. They simply mark another step in the work of determining the value in poultry feeding of the nutrient elements of animal feeds, and open the way to further investigation.

Yeast Feeding Trials.—To determine something of the value of the yeast products which have lately been offered for sale to California poultry keepers, a feeding trial with S. C. White Leghorns, White Plymouth Rocks, and Rhode Island Reds was started January 25, 1923, by J. E. Dougherty and S. S. Gossman and will be continued for approximately one year. The leghorns used were divided into three lots. Lot I, consisting of 161 hens and 12 males, was fed yeast; lot II, consisting of 79 hens and 6 males, was the check pen and received no yeast; and lot III, consisting of 3 breeding pens of 20 hens and 1 male each, was fed yeast and the eggs produced used for hatching. The White Rocks and Rhode Island

* Report of the College of Agriculture and Agricultural Experiment Station, University of California, 1914–15, p. 138; 1915–16, p. 58; 1921–22, p. 140.

Reds consisted of two lots, of which the larger lot (IV) received yeast and the smaller (V) did not.

All pens were fed morning and night the same basic ration consisting of a well balanced grain mixture, a dry mash which was kept before the birds in self feeding hoppers, and freshly cut and chopped greens which were fed in green feed hoppers daily. The yeast pens were fed, in addition, granulated, dried yeast at the rate of 5 pounds of yeast to each 95 pounds of the regular "University" dry mash* fed (5 per cent of dry mash).

The egg production for the first 90 days of this trial are given in the following paragraph. The difference in production was somewhat greater with the two heavy breeds than it was with the Leghorns. Whether these differences will be reduced or increased as the trial continues, remains to be seen.

During the first 90 days, lot I, which received yeast, averaged 49.2 eggs to the hen; lot II, the check pen, averaged 48.9 eggs to the hen; and lot III averaged 50.3 eggs to the hen. A more noticeable difference was found in the case of the heavier breeds. The average production for lot IV (White Plymouth Rocks and Rhode Island Reds receiving yeast) was 35.1 eggs; while lot V, receiving no yeast, averaged 31.7 eggs. Whether these differences will be reduced or increased as the trial continues remains to be seen.

The initial and final weights of the fowls used in this trial were taken, but the difference was not found to be appreciable. The results from hatching do indicate, however, that yeast had no pronounced effect in improving the hatching quality of the eggs.

To determine the effect of granulated, dried yeast upon the rate of growth of rabbits, W. E. Lloyd fed this product to three lots of young rabbits which were approximately seven weeks of age when the trial was begun. Lot I was fed a daily ration of dry, whole barley, alfalfa hay, and dry mash; greens were given twice a week. Lot II was fed the same ration plus 5 per cent of dried yeast added to the dry mash. Lot III was fed the same ration as lot I without the dry mash. Lot I made an average gain of 183 per cent, or 2.56 pounds; lot II, of 100.4 per cent, or 2.74 pounds; and lot III, of 164 per cent, or 2.29 pounds. The results of this trial, which continued for eight weeks until the rabbits were ready for market, indicate that when well balanced rations were used, the addition of yeast was of no particular benefit.

Observations on Tint in White Eggs.—The California marked requires not only that eggs be fresh and weigh 24 ounces to the dozen, but also that they be white in color, if they are to command the highest price. Eggs visibly tinted with brown are placed in a lower classification and sell for less.

Observations of the tinted eggs of a number of hens in the Station flock were begun by J. E. Dougherty and S. S. Gossman on January 5, 1923. The hens were trapnested and one egg from each hen was taken at the beginning of each week, the amount of tinting recorded on the basis of a color chart, and the egg blown for permanent preservation. For example, in the first seven day period ending January 11, hen no. 6602 laid an egg with a medium heavy tint which was given the value 3. The following week she laid eggs that were somewhat less tinted. The third week her eggs were still lighter in tint.

* For details of ration, see Circular 242, May, 1922, of the College of Agriculture and Agricultural Experiment Station, University of California.

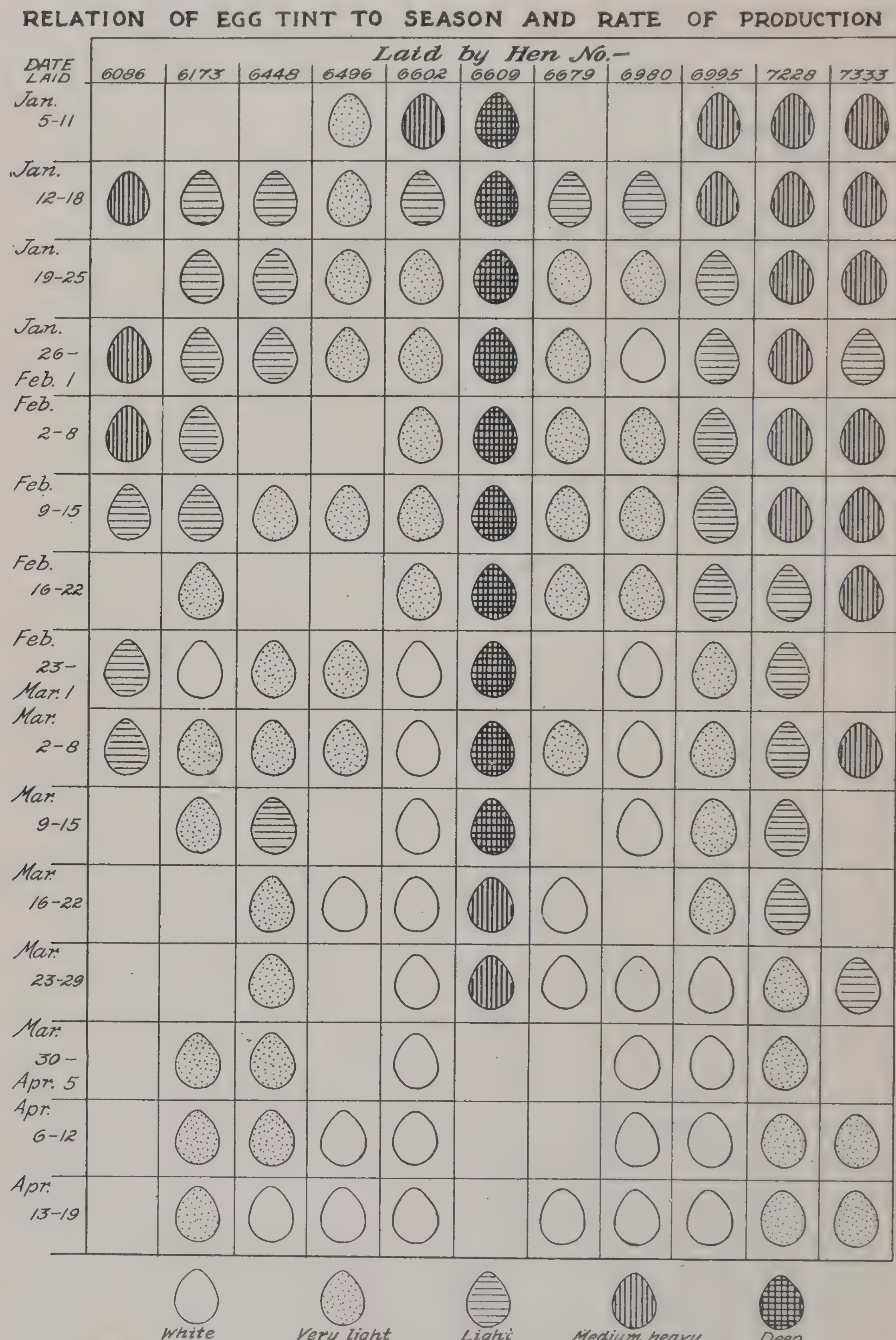


Fig. 106.—Diagram of a tray of eggs showing tinting

Data kept from January 5 to April 19 indicate that most of the hens observed were laying eggs with a strong tint in early January, whereas in April at the time of increased production, eggs from the same hens had faded in color until they were apparently pure white. This furnishes an explanation of the continued large percentage of tinted eggs being produced in California, even though only apparently white eggs are incubated. A majority of these tinted eggs fade out sufficiently during the spring hatching season to escape detection and consequently are incubated. Since color of shell is an inherited character, the pullets hatched lay more or less tinted eggs.

In order to reduce the percentage of tinted eggs produced from year to year, then, poultry keepers should trapnest and discover those hens which lay tinted eggs during periods of low production. Probably the best time to trapnest for this purpose is following the close of the molt when production is being resumed after the annual rest period. By eliminating every hen which shows the brown egg taint and by using only breeding males that are descended from a line of pure white egg layers, the production of tinted eggs should be rapidly reduced.

Monthly Production of High and Low Producers.—In order to observe the relation between the production of poor and good layers, J. E. Dougherty and S. S. Gossman charted the monthly production of a large number of pullets entered in the egg-laying contests conducted under the supervision of the Poultry Division. The annual production records of these birds were divided into eight groups of 25 egg intervals, beginning with the low group laying 75 eggs or less, and ending with the high group laying from 226 to 250 eggs, inclusive. In figure 107 however, four of the intermediate groups have been omitted in order to make the groups represented more distinct to the reader.

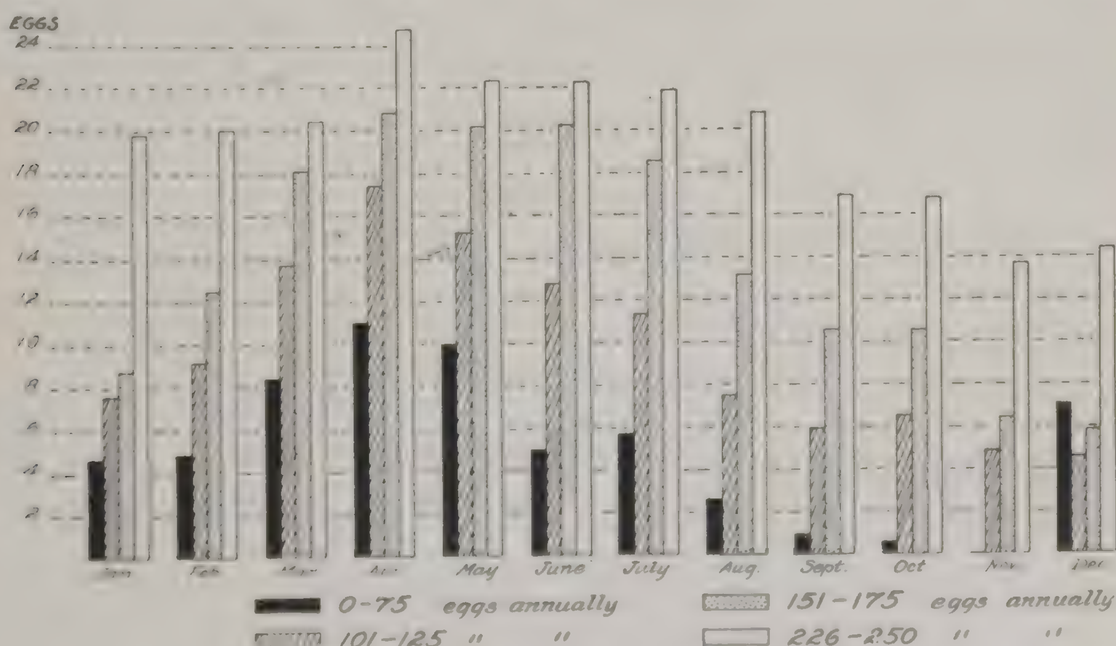


Fig. 107.—Eggs laid each month by good, medium, and poor producers in the egg-laying contests conducted under the supervision of the Poultry Husbandry Division. Trapnest records of these contests furnished data from which this chart was drawn.

It is noteworthy that the low producers had a low average not only for annual production but for every month in the year. Likewise, the high producers not only made a high annual production but also outlayed the other groups every month. With the exception of the December production of the low group, the greater production of each successive group was rather uniformly distributed over every month in the year. The medium low producers, for example, did not lay as well as the high producers during the period of heaviest production in April, May, and June. They then dropped rapidly while the high producers continued laying through the summer and fall with a much more gradual reduction in yield. It is true that the difference in the monthly production of the groups is more marked during the summer and fall than during the winter and spring.

Relation of Age to Production and Hatching Qualities.—In order to obtain data on the relation of age alone to production, S. S. Gossman compiled and studied the four-year trapnest and hatching records of 224 hens in the Station flock. He found that over 95 per cent of these hens laid more than 130 eggs (the average annual production in commercial laying flocks in California in 1922) during the first two years; 84 per cent exceeded this number through the first three years and 55 per cent through the full four-year period.

The hatching records of the hens indicate a gradual decline in fertility and hatching quality of the eggs after the second year. The offspring from these hens have been numerous, however, and have given every evidence of the inheritance of vigor and fecundity. Many of these female offspring are now in their third laying year and making splendid records. It is evident that laying hens should not be discarded merely on account of age but should be kept as long as they lay profitably.

Correlation Between Summer and Annual Production.—In order to determine the correlations between the summer and the annual production of hens S. S. Gossman kept records of the number of eggs laid each year for four years by 224 S. C. White Leghorn hens in the flock at the University Farm. The following table shows the results:

	Eggs, 1st yr.	Eggs, 2nd yr.	Eggs, 3rd yr.	Eggs, 4th yr.
Mean annual production	147.97	156.43	151.94	136.34
Mean summer production	47.43	52.04	50.78	43.616
Ratio of annual to summer production	1:3.02	1:3.03	1:3.02	1:3.11
Coefficient of correlation	.487±.034	.497±.034	.581±.0298	.663±.0253

The coefficients of correlation given above show that there is a reasonably close relation between summer production and the number of eggs laid for the year. It is also interesting to note from these figures how consistent is the ratio of summer to annual production. The summer production is practically one-third of the annual production for each of the four years.

These data are of great value to the breeder who wishes to obtain a reasonably accurate estimate of the laying qualities of his hens without trapnesting the entire year.

Egg-Laying Contests.—Three egg-laying contests were conducted by the poultry departments of the farm bureaus and supervised by the Poultry Division of the College of Agriculture in coöperation with the Agricultural Extension

Service. The California Farm Bureau Egg-Laying Contest at Santa Cruz will complete its fourth successful year September 30, 1923. The third contest was won by Alex Stewart of Santa Cruz, whose entry of ten hens laid an average of 265.2 eggs each for the year. The entry of Hanson's Poultry Farm of Corvallis, Oregon, was second with an average production of 254.7 eggs for the year and the entry of L. A. Thornewill of Santa Cruz won third prize with an average production of 233.8 eggs.

The outstanding feature of this contest was the great record made by Columbia Belle of the winning pen. This hen produced 324 eggs in 365 days, the highest record which at that time had been made in any official egg-laying contest in this country. Lady Jewell, another Leghorn, later surpassed this record at the Western Washington contest.

The annual Southern California Farm Bureau Egg Laying Contest at Pomona closed September 30, 1923, with an average production of 175 eggs. The contest was won by the entry of M. L. Frick with an average production of 203¼ eggs. The cup for highest hen was won by E. E. Eissenberg of Riverside whose hen, no. 201, laid 274 eggs during the contest year.

The second Sonoma County Farm Bureau Egg-Laying Contest at Petaluma began November 1, 1922, with 43 entries. The second contest was won by the entry of H. R. Thomas with a record of 197.4 eggs. Mr. Thomas' hen, no. 226, also won the prize for highest individual performance with a record of 304 eggs in 364 days.

Especially to be commended is the continuation by the Southern Farm Bureau Laying Contest at Pomona, of the research work begun last year.* The two problems being worked out this year under its auspices are the frequency with which fresh greens should be fed laying and breeding hens and the evaluation of certain substitutes for these greens during the winter season.

A commendable modification in the rules governing the Pomona contest this year is that hens laying 50 per cent or more of eggs that weigh less than 22 ounces to the dozen are disqualified for individual prizes in the month when this occurs, and for annual prizes if 50 per cent of the eggs laid weigh less than 22 ounces for the six months period beginning February 1. Two such hens in any one entry will disqualify the entry.

Hatching Turkey Eggs Artificially.—Because turkey eggs have been considered so much more difficult to hatch in incubators than hen eggs, artificial incubation has not been considered desirable. The results which W. E. Lloyd obtained in hatching turkey eggs in incubators at this Station, however, have not shown this to be true. Equally as good results were obtained with turkey eggs as with hen eggs. The eggs were incubated for 28 days and great care was taken to keep the air of the egg chamber reasonably humid throughout the hatching period.

The five hatching trials in incubators completed this season gave results ranging from 55.4 per cent to 72.8 per cent of all eggs set, and from 77.6 per cent to 93 per cent of the eggs left in the incubators after the second test.

Oyster Shell vs. Limestone Grit as a Source of Lime for Poultry.—A feeding trial was carried on by J. E. Dougherty and S. S. Gossman with two pens of Single Comb White Leghorn hens to determine whether limestone grit would prove as satisfactory as oyster shell in supplying enough lime to laying hens to

* Report of the College of Agriculture and Agricultural Experiment Station, University of California, 1921–22, p. 144.

enable them to produce eggs with strong shells. Both pens were housed and cared for in the same manner, except that pen No. I had free access to hoppers of both crushel oyster shell and limestone grit, whereas pen No. II received only the limestone grit. The soil in the yards was a heavy clay loam free from grit or gravel.

The hens were trapnested and all eggs laid by each hen were carefully examined for evidence of weak shells. During the breeding season as many as possible of these eggs were hatched to see whether the hatching quality was affected in any way.

During the period of the trial (March 21 to September 30, inclusive) the grit pen consumed 191.7 pounds of grit to each 100 hens and gave an average production of 46.4 per cent. The grit and shell pen consumed 17.1 pounds of grit and 138 pounds of shell to each 100 hens and gave an average production of 40.4 per cent.

Of 64 eggs collected from pen No. I on March 30 and averaging 1.99 ounce each, 3 per cent had weak shells. Of 69 eggs collected from pen No. II and averaging 1.96 ounce each, 4.4 per cent had weak shells. The percentage of weak shells, however, was not constant. For instance, on May 22, of 72 eggs from pen No. I, averaging 1.94 ounce in weight, 8.3 per cent had weak shells, while of 70 eggs from pen No. II, averaging 1.83 ounce in weight, only 1.4 per cent had weak shells.

Of the hatching eggs set, 86 per cent from the grit pen and 76 per cent from the shell and grit pen hatched strong chicks.

The eggs laid by the pen receiving only the limestone grit proved to be equally as good in every respect as those laid by the pen receiving both oyster shell and grit, and the health of the hens was also equally good. The grit pen suffered an 8 per cent and the shell and grit pen a 12 per cent mortality.

RURAL INSTITUTIONS

Land Settlement.—The State Land Settlements at Durham and Delhi have during the past year, as in previous years, given opportunity to study problems of community development, credit, and marketing in considerable detail. Since the organization of the settlement at Durham in 1918 and that at Delhi in 1920, records have been kept of the financial transactions of each settler. In addition to their direct purpose of accounting, these records serve as the basis of estimating, from actual costs of development, the financial needs of settlers. They have been found to be the only satisfactory basis for determining the amount of help a settler must have if he is to enjoy any measure of success. With the experience at Durham and Delhi as a guide, future settlements may be built with a better knowledge as to where and how money needed in agricultural development is to be obtained; where and how settlers are to be sought; and how the settlers must be aided and directed so as to enable them to use their money, effort, and time to the best advantage. Heretofore, the attention of those administering the affairs of irrigation districts has been centered mainly upon engineering problems. It has been assumed that closer settlement and agricultural development would come without aid or direction. It has been shown by experience in connection with the California State Land Settlements that settlers with enough money to meet the financial burdens incident to

changing raw land into improved farms are not available in large numbers. At Durham the farms which have made the highest returns upon the capital invested have expended on the average for development nearly \$120 an acre, for live stock \$95, and for equipment about \$20. This is exclusive of the cost of a dwelling house. The total, which runs well above \$200 an acre, must be added to the cost of raw land. There is a large difference between the amount of capital possessed by settlers who can be found in sufficient numbers to people our rural districts and the amount required to turn raw land into intensively cultivated farms. This deficiency of funds is supplied under the California State Land Settlement Act through its provisions for a small first payment for land, a low rate of interest, a long term of payment on the amortization plan, and loans for improvements, equipment, and live stock, with terms similar to

Fig. 108.—Home of a Durham settler. A good set of buildings is one of the requirements if a farm is to be both an efficient producing unit and a desirable place to live.

those governing the purchase of land. With this credit and with advice and direction in the planning of buildings, marketing of crops, budgeting of expenditures, and preparation of land, and in general farming operations, the settler is able to become established on a business basis.

These settlements have demonstrated the State's opportunity of making rural life more attractive. It is gratifying to note the early application of the fundamental results of experience in the state settlements to the colonization of land by private interests. Individuals and corporations interested in the settlement of rural California have come to realize that colonization is more than a mere brokerage business, and that when the settler has made his first payment on his land, the job of the vendor has just begun.

The Division of Rural Institutions has had the coöperation of George C. Kreutzer, superintendent of the Durham Settlement, and Walter E. Packard, superintendent of the Delhi Settlement, in the collection and analysis of the records in the two colonies.

Results in the Delhi State Land Settlement, which is a part of the Turlock District, show in a striking way the economic loss the state has sustained by delay in bringing the land under irrigation.

When this settlement land was bought in 1920, it had never been irrigated. It looked exactly like the land above the canals. It was being rented on a dry basis for 50 cent an acre. Two years later this land, irrigated and seeded with alfalfa, was bringing an annual rental of $20 an acre, or forty times the dry income. Settlers who were using their hay to feed dairy cows were getting a large return. Practical fruit growers of the San Joaquin Valley believe that this area of 8000 acres will in ten years have an income from fruit of $1,000,000 a year, or *250 times that obtanied before closer settlement and intense culture were adopted.*

Fig. 109.—A scene at Durham. Good livestock and equipment help to pay for a farm. The dairy cow has helped in many cases where fruit growing was the ultimate aim. To obtain good equipment, however, the farmer must have adequate funds.

Through an arrangement between the University and the Department of Public Works of California, George C. Kreutzer and David Weeks, working under the direction of Elwood Mead, have devoted some time to the investigation of land settlement conditons in irrigation districts.

The irrigation records of the last U. S. census and investigations made during the past year concur in showing that there is now in California an area of 2,000,000 fertile acres under irrigation works which is not being irrigated. More than half of this area is in northern California. Its soil and climate make possible an agriculture so varied and of such high acreage value as to offer a unique opportunity for development. The land in northern California alone will provide comfortable homes for 50,000 families and will produce crops worth $100,000,000 a year. But to secure these results, houses and barns must be built on 50,000 farms, and thousands of dairy cows and work horses must be bought by settlers.

Much of this unimproved land is in irrigation districts. Of the 90 districts organized, 78 have been created in the last 10 years and bonds to build 53 have been sold. These 53 districts have an aggregate area of 2,736,696 acres. Bonds for the other 37 districts have not been sold, but when sold and the works constructed, they will add 1,199,156 acres to the area under discussion. Unless irrigated farms follow canals more closely, the financial strain imposed by this one-sided development will in time be severe.

Sixteen California districts have been studied in considerable detail. They represent typical conditions in northern California. They have a total irrigable area of 826,000 acres ranging from foothill to valley lands along the Sacramento and San Joaquin rivers, and from old developed sections about Fresno to new projects in other parts of the state. In these 16 districts 378,000 acres, or more than 45 per cent, are not irrigated. Of the 55 per cent of this land which is being irrigated, not more than half is giving a full return because the land is not properly prepared and is not cultivated with the care and skill which irrigated culture in this state requires. One common mistake is spreading the available labor and capital over too many acres. Lack of coöperation between farmers and of coördinated plans for development are others. In two districts on the west side of the San Joaquin river, irrigated farms of 80 and 160 acres are common, and one farm of 400 acres was being operated by its owner with no more help than could be profitably used on 80 acres. When asked why he didn't dispose of part of his farm, this owner stated that no buyer was able to give enough cash as a first payment.

In the rice lands of the Sacramento Valley, thousands of acres are included in individual farms. A single rice farm in the Glenn Colusa district has an area of 10,000 acres. Proper drainage and intensive cultivation on smaller units with segregation of the rice fields and subdivision and settlement of the general farm crop lands would prevent the spread of water grass, tule, and cat tails, and would create the permanence and stability essential to success.

It is not necessary, however, that the land be subdivided before changing to irrigated agriculture. Some of the best orchards and vineyards in the state have been planted and brought into bearing through large scale operations, the land leveled, the trees planted, and the ground cultivated with hired labor using the best of equipment. As a rule, however, this kind of development is a preparation for colonization, and large holdings in a district usually indicate a dormant condition so far as improvements are concerned.

A special study of the land settlement problems of Australia, Palestine, and India, in their relation to California methods is being made by Elwood Mead. A number of translations have been made of documents published by European countries, which show that the tendency in the older countries is to go much farther in the assistance given settlers than is now being done in the United States.

The divisions of Soil Technology, Farm Management, and Agricultural Education have given much valuable help in the research work of this division.

Marketing.—At the request of several groups of farmers, H. E. Erdman made a study of the marketing of sweet potatoes, cantaloupes, and watermelons in central California, and of white potatoes in various parts of the state.

This state produces less than 1 per cent of the sweet potato crop of the United States. Fully two-thirds of its sweet potato acreage is in Stanislaus and Merced counties, the remaining third being grown in scattered areas in half

a dozen counties in the southern part of the state. Of the estimated crop of 880,000 bushels produced in this state in 1921, probably 600,000 bushels were produced in the northern section and fully 80 per cent of this was shipped out by rail. This is a marked contrast to sweet potato marketing in such of the southern states as Alabama where during the same year but 2.1 per cent entered carlot shipments, and Arkansas, one of our principal competitors, where but 5 per cent was shipped by rail, the remainder being consumed locally.

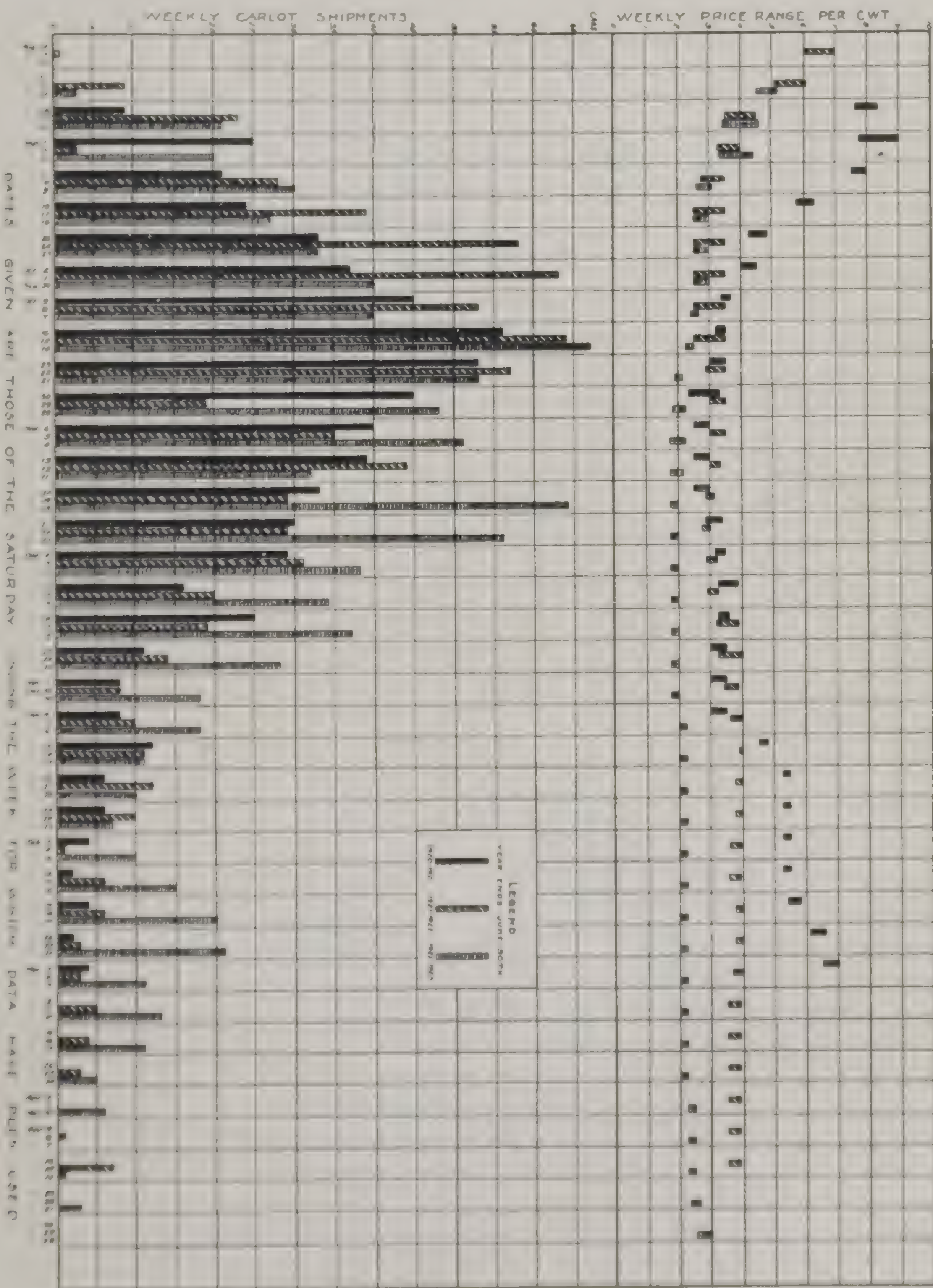
The product of the southern section is consumed almost entirely in Los Angeles and its environs to which it is hauled by truck. This simplifies the marketing problem. Producers sell in large measure direct to wholesalers and jobbers, and to some extent even to retailers and to consumers. The producer realizes a higher percentage of the price paid by the consumer and knows what he is going to get before the product leaves his possession.

In the case of the carlot shipments, however, the grower has had considerable difficulty during the past few years. Distribution of the northern California crop is confined mainly to the area west of the Rocky Mountains, reaching from Los Angeles in the south to Vancouver on the north and Denver on the east. Growers have found the greatest difficulty in obtaining orderly distribution and in price control. Thus far there has been lack of commercial storage space (aside from cellar storage). Where commercial storage has been attempted, it has not been entirely successful because certain technical problems of storing under California conditions have not, or had not until very recently, been solved. The problems of price control have arisen largely out of irregular distribution and the keen but frequently unscrupulous competition which exists.

Attempts have been made during the past several years to market coöperatively so as to secure more even distribution geographically and in point of time, and to prevent price manipulation. During the season of 1920, the coöperative association was reasonably successful in its efforts to distribute the crop in an orderly way, but accumulated a deficit of nearly $30,000 as a result of several unbusinesslike practices. The 1921 crop was also marketed largely coöperatively, although a much smaller proportion was under the control of the association. Out of operations of that season, the association repaid most of the debt incurred the previous year, but this process weighed relatively heavily on the smaller number of members who had remained in the association. At the beginning of the 1922 season a strenuous effort was made to reorganize and to bring at least 85 per cent of the total acreage into the association's control. This, however, was not accomplished and the association did not function during the season of 1922, a year when any service it might have rendered was particularly needed. The crops of both sweet and white potatoes for the country as a whole were the largest on record, hence sweet potato prices for the season were most unprofitable. The accompanying chart illustrates the movement of the crop during the past three years. It appears that the movement was most regular during the year when the association was strongest (1920–21).

The white potatoes of the state are produced in three main areas. A group of counties in the Delta section of the Sacramento River Valley produce the major portion of the fall crop. A group of the coast counties produce principally early potatoes which very largely supply San Francisco and some of the towns nearby with their early potatoes and with a portion of their high grade fall potatoes. The southern counties during the spring and early summer months supply Los Angeles and surrounding towns, and in addition send large quantities

Fig. 110.—This chart shows that there is room for more orderly marketing of the sweet potato of California. Adequate storage is needed. These price curves do not tell the whole story, since they are for field run and cellar stored potatoes only. After the new year, prices of properly cured stock are higher than potatoes stored in cellars.



of potatoes out of the state mainly to middle western and southern points. The Delta potatoes are distributed throughout this and adjoining states during the fall and winter months. In addition, potatoes from Idaho, Washington, and Oregon enter our principal markets and compete with all varieties produced here. In most of the potato producing sections spasmodic attempts have repeatedly been made to market coöperatively but only in a few instances has even temporary success been attained.

Coöperative marketing of annual crops such as sweet and white potatoes has thus far been much less successful in this state than it has with fruit crops. A study of the attempts at coöperation in the sale of sweet and white potatoes has served to emphasize some of the fundamental difficulties to be met in the marketing of such crops as contrasted with the problems faced by the growers of orchard fruits. Probably the most serious of these arises out of the instability of the producers, i.e., the tendency to shift from crop to crop. This is of particular importance in the case of tenants. Thus in the sweet potato area about Turlock, growers are likely to shift from the growing of sweet potatoes one year to the growing of melons or some other crop in another year. In some of the newer sections of the state this tendency is even more marked. This is in part due to the fact that sweet potatoes cannot be grown profitably on the same land for more than one to four years in succession, at least so long as present methods are used. A third difficulty is that of financing. Many of the growers are in difficult financial straits and are such poor risks that banks will not lend to them directly. Hence, it is necessary for speculators to finance many of them. Under such situations, coöperation is very much more difficult and is more temporary in nature than in the case of orchard fruits where an association may tie a group of growers together through long time contracts until an efficient marketing association can be built up, with little danger that he or the land he owns will cease producing the crop in question.

SOIL TECHNOLOGY

Progress in the Soil Survey

Areas Surveyed.—During the year, three soil surveys have been completed, one revised, and another started.

The Soil Survey of the Gilroy Area by S. W. Cosby, assisted by E. B. Watson of the U. S. Bureau of Soils, covers about 200,000 acres in Santa Clara County and includes practically all of the agricultural lands of the county south of the town of Coyote, as well as adjacent hill land. The soils are classified into four general groups: Residual, including six separate series of which there were seven types; Old Transported, including seven series of which ten types were found; Recently Transported, including six series shown as seventeen types, and Miscellaneous, in which four separations were made. The Bodfish series, an old transported soil, is the only series found in this area which had not been previously recognized in California.

With the exception of the soils mapped under the general heading Miscellaneous, which includes rough broken and mountainous land, practically all are under cultivation.

The Survey of the Coachella Valley Area was made by A. E. Kocher and G. W. Harper of the U. S. Bureau of Soils coöperating with this division. This

survey covers the agricultural land, both tilled and untilled, of the Coachella Valley from the northern end of the Salton Sea to a point some miles above Indio. About 350 square miles were mapped.

The valley is a depressed, treeless basin, the floor of which, in the area surveyed, varies from about sea level to 250 feet below. It has a hot, arid climate with an average rainfall of about three inches a year. Geologically, the soils are very young, and the differences occurring in the profile are due more to deposition than to soil development. The soils are all of water-laid origin, although considerable areas along the margins of the valley have been redistributed by winds. They are all irregularly stratified, gray or brownish gray in color, highly micaceous, rich in lime, and low in organic matter. In addition to rough stony land and dunesand, the area contains four groups of soils: old valley-filling, recent alluvial stream-land deposits, lake-laid deposits, and wind-blown materials. The first, occurring on the fans or slopes between the valley floor and the mountains, are all sandy, porous, and more or less gravelly and stony. They are included in the Superstition series, comprising four types. The second division, comprising the Indio series, lies in the trough of the valley and is composed of fine textured, stratified sediments giving rise to six soil types. The lake-laid group includes three types in the Woodrow series, low, flat, relatively impervious, poorly drained soils, bordering the Salton Sea. The wind-blown soils are grouped into the Coachella series—a new series composed of gray, or brownish gray, highly micaceous, pervious, wind-blown materials derived from granitic or quartz-bearing rocks. The surface is duney and uneven, but when levelled, the soils are well adapted to grapes, grapefruit, and early vegetables. Two types and two phases are mapped. These soils, together with the light textured types of the Indio series, are the most important in the area. The Woodrow soils, together with some of the lower areas of heavy textured soils, are of low value because of alkali. The agriculture of the valley is highly specialized, consisting of the growing of grapes, dates, grapefruit, onions, and early vegetables, in addition to cotton, alfalfa, grain hay, and other staple crops.

Because of a break in the Colorado River levee an area of about 35,000 acres of the Palo Verde Valley was flooded after the soil survey was made by A. E. Kocher in 1922. The flooding resulted in a deposit of silt and sand, covering portions of this area to a depth of several feet. It was remapped during 1923 by Kocher and one new series found to have been formed.

The Soil Survey of the Hollister Area includes 200,000 acres lying in the northern part of San Benito County and comprises practically all of the improved agricultural land in the county. The survey was in charge of S. W. Cosby, assisted by E. B. Watson and W. G. Harper of the U. S. Department of Agriculture.

On the east, west, and south, the area is bounded by mountain ranges, and on the north by the county boundary along the Pajaro River. Elevations range from about 100 feet above sea level to more than 3000 feet.

The soils are derived mainly from sedimentary rocks. Some of the soils having their origin in the Gabilan Range in the southwestern part of the area contain some granitic material. On the basis of their mode of formation, the soils were divided into three main groups, residual, old transported, and recently transported soils. Of the first, two series and four types were mapped; of the second group, six series of one type each; and of the third, six series

consisting of fourteen types and one phase. Three classes of miscellaneous materials, mainly non-agricultural in character, were mapped.

The climate is characterized by a warm, dry summer and a rainy winter season, the annual precipitation amounting to about 14 inches. The regional drainage is well developed except in the low-lying Bolsa, which also has alkali in injurious amounts. Formerly the principal crops were livestock, grain, and hay, but during the last generation these have been gradually replaced by more intensive crops. The U. S. census for 1920 reports more than a million dollars worth of fruit and a similar amount of vegetable seeds produced in the county.

Percolation of Water Through Soils.—Studies on the rate of percolation of water through soils have been continued by E. V. Winterer.* Soils of different texture were studied under differents heads of water. The percolation was continued for periods ranging from 150 to 275 days. A typical curve showing the rate of percolation in cubic centimeters per hour is shown in figure 111. The data for the construction of this curve were taken from an 8-inch tube filled with the gravelly phase of Yolo fine sandy loam, with a three foot column of soil and a three foot head of water. The first measured water came through at the rate of 682 cc. per hour, and from that point on the rate decreased rapidly

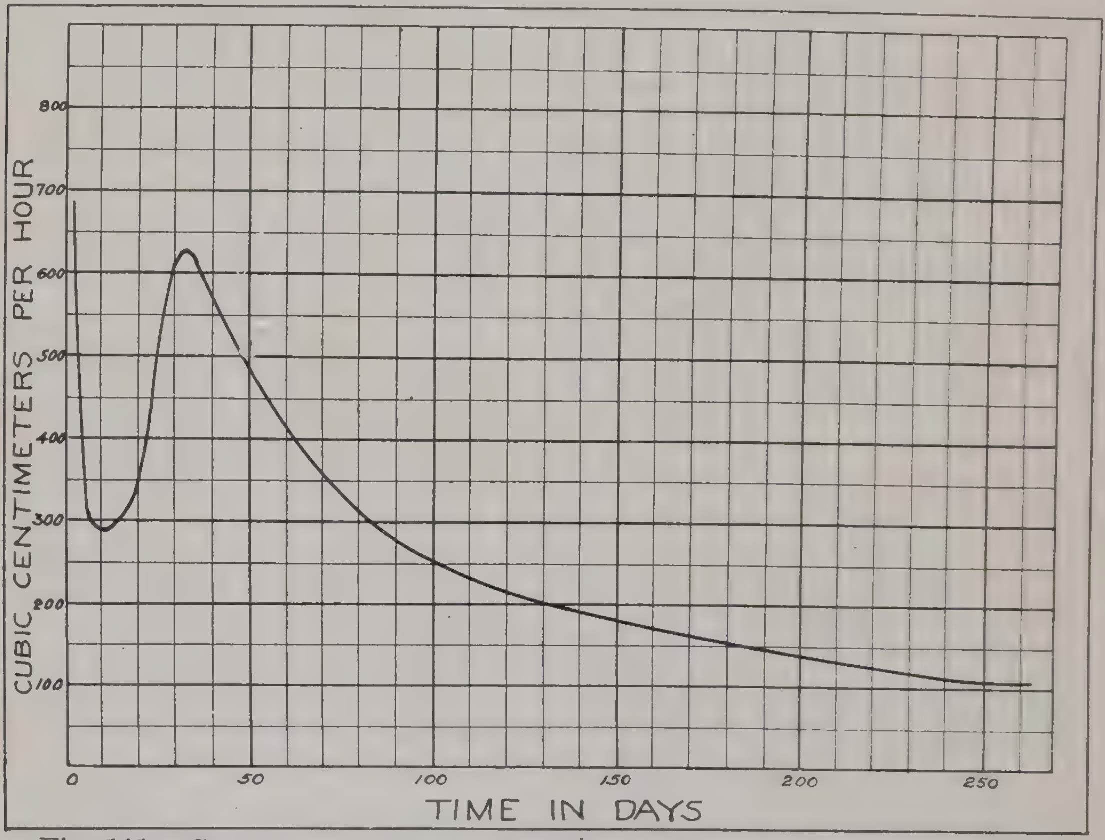


Fig. 111.—Curve showing rate of percolation through a threefoot column of gravely phase Yolo sandy loam under a three-foot head of water.

until the eleventh day, when the rate was 287 cc. per hour. From the eleventh day the rate increased rapidly until the thirty-second day. From the thirty-second day until the end of the experiment, the rate of flow decreased. The head of water operating on this tube was not altered in any way from the start to the close of the experiment, and the variations in the rate of flow caused by agencies within the soil were well shown.

* Report of the College of Agriculture and Agricultural Experiment Station, University of California, 1921–22, p. 160–61.

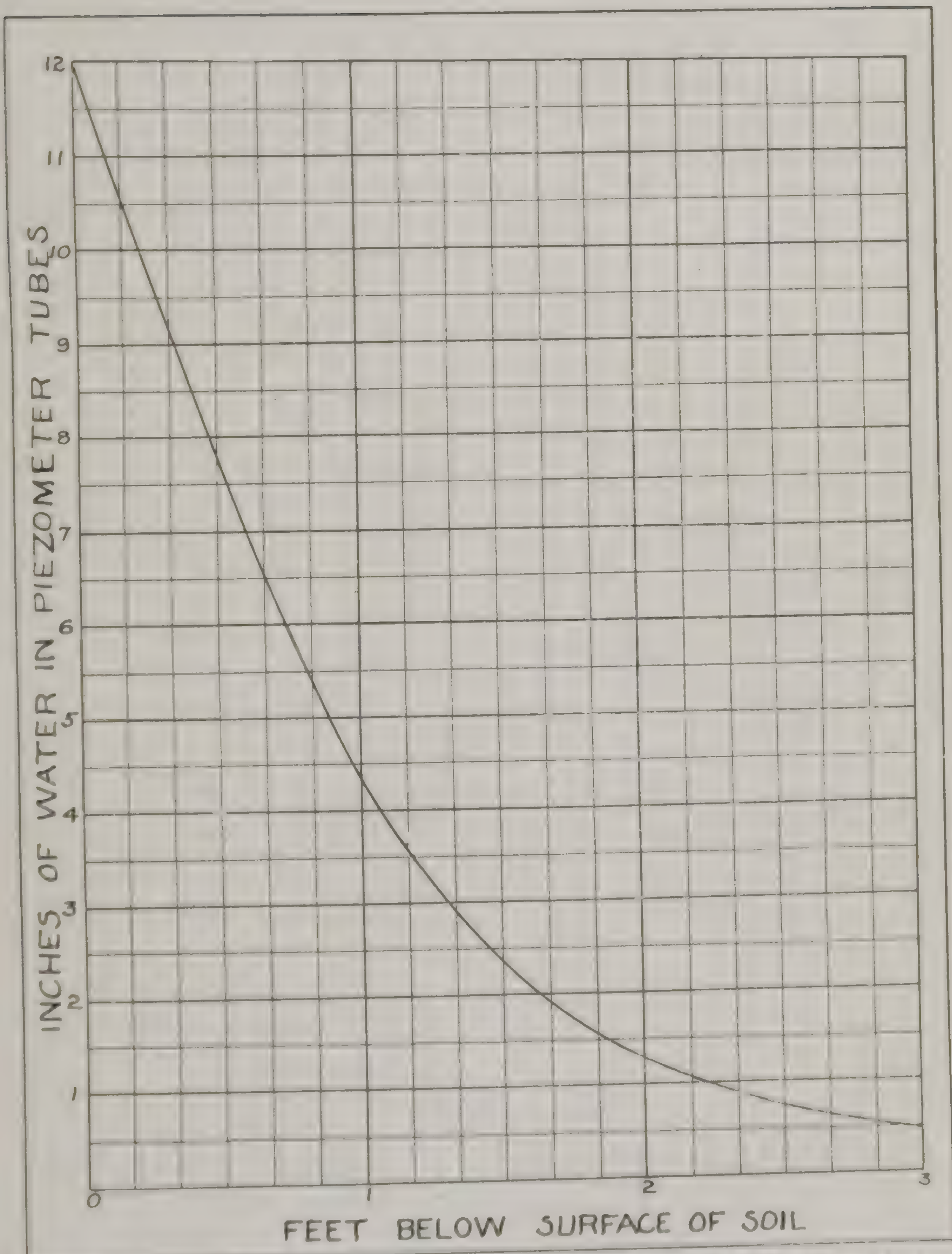


Fig. 112. Hydraulic gradient through Oakley fine sand with a one foot head of water over a three-foot column of soil.

Carrying the studies of the rate of percolation farther a six-inch tube, four feet high, was set up. This tube contained a soil column 35 inches long with a 12-inch head of water operating on the surface of the soil column. Piezometer tubes were fitted into the side of the tube at intervals of about six inches. Readings of the height of the water standing in the piezometer tubes were taken daily and they are plotted in the curve shown in figure 112. The depth of the liquid in the piezometer tubes is plotted as ordinate and the depth of the piezometer tubes below the surface of the soil is plotted as abscissa. The form of the curve indicates that the hydraulic gradient is not a straight line but a uniform curve which shows that the coefficient of friction throughout the length of the soil column is not the same per unit of length.

The evidence brought out from this study on the rate of percolation of water through soils seems to bear out that: (1) the presence of a water table does not decrease the rate of percolation; (2) an increase in head results in a greater loss by percolation and is not dependent upon the time that the head of water is increased; (3) the rate of percolation through a gravelly phase of a sandy loam is about twelve times greater than through loam, all other things being equal; (4) there is a striking similarity between all of the percolation curves, with a decrease in flow followed by a second maximum and then a gradual diminishing of the flow; (5) the variations in the rate of percolation are dependent upon the effective head operating on the soil column, which varies according to the dispersion of the soil colloids, the loss or gain of organic material, the gradual silting up of the pore spaces of the soil, and the loss of colloidal and fine clay material in the drainage water; (6) the amount of colloidal material leached out of the soil varies directly with the rate of percolation; (7) the effective head varies with the flow of water at any point in the soil column and is dependent upon time; (8) the hydraulic gradient in a column of soil with a head of water operating upon its surface is not a straight line but a uniform curve which in about ten days approaches a straight line for the soil used; (9) a dilute solution of copper sulfate increases the rate of percolation by altering the structure of the soil; and (10) an increase in the rate of percolation may be obtained with a dilute solution of formaldehyde; the organic material in the soil is leached from the surface and moves through the soil column as a falling pillar.

Rice Soils.—In connection with the studies on the physical properties of adobe soils with special reference to those used for rice,* E. V. Winterer has found that the method of mechanical analysis of the Bureau of Soils did not give sufficient information on soil particles which fall in the clay group (particles having a diameter of less than 0.005 mm.). In his endeavor to obtain further separation of the clays, he has constructed an apparatus somewhat after the design of Sven Odén of the University of Upsala, Sweden. The method depends upon the relation existing between the diameter of the particles and the rate of fall through a liquid. The particles are weighed continuously and automatically as they fall on a pan arranged near the bottom of a cylinder containing the clay particles in suspension in a liquid. By mathematical calculations and the use of Stoke's law, it is possible to determine the size and distribution of particles and other information which it is hoped will clear up some of the perplexing problems on clay soils. In one soil which was examined

* Report of the College of Agriculture and Agricultural Experiment Station, University of California, 1921–22, p. 162.

by this method, the smallest size measured had a diameter of 0.00044 mm. Other soils which have not yet been thoroughly examined are known to contain particles much smaller than this.

Soil Moisture Studies in Relation to Tree Injury in Placer County.—In an endeavor to determine the cause of injury to trees, especially plums, in the vicinity of Loomis, Penryn, Newcastle, and Auburn, R. E. Storie began a detailed study of soil conditions in this neighborhood.

The soils of this region in which trees are planted, are all residual, derived from either basic igneous rocks or granites, and they vary in depth from a few inches to six feet. Trees on all types showed injury.

Detailed surveys were made in three orchards, one located on Aiken loam, another on Holland gravelly sandy loam, and the third on Holland sandy loam. The condition of each tree was noted as well as the surface and subsoil texture, the depth and drainage, and the moisture conditions of the soil at each tree. There does not appear to be any direct relation between the depth of soil and the condition of the tree except as the moisture content is influenced thereby.

Simultaneous studies by J. P. Martin of the Division of Plant Pathology indicate that the direct cause of injury may be an organism, but Storie's later studies seem to show that trees which have suffered either from excessive or deficient moisture are more susceptible to attack. Drainage is markedly deficient in many small local areas during the wet season, and at other times the soil becomes exceedingly dry and the trees undoubtedly suffer from drought for long periods.

Mechanical Analysis of Soils.—Mechanical analyses of over 300 soil samples from the Lancaster, Palo Verde, Gilroy, and Hollister areas have been made by E. V. Winterer and C. J. Zinn, using the Bureau of Soils Method. This work is done as a part of the coöperative work with the U. S. Bureau of Soils and will result in greatly hastening the date of publication of these reports.

Mechanical analyses have also been made of a number of soil samples submitted by engineers to determine the suitability of the materials for use in hydraulic fill dams and as a playing field for the stadium.

Stadium Playing Field.—Extensive studies have been made on a design for the stadium playing field by Chas. F. Shaw and Walter W. Weir in coöperation with other members of the staff, H. R. Howells, a senior student, and the California Memorial Stadium Commission. The requirements are rather exacting, for the field must have sufficient drainage that it can be played upon at all times, yet must be firm enough to withstand the rough treatment of playing and must grow a satisfactory sod.

Plans have been submitted to the commission for a built up field overlying the impervious hydraulic fill. Tile drains laid 40 feet apart and designed both for drainage and sub-irrigation will be placed on top of the impervious layer. Over the drains will be 4 inches of crushed rock, 4 inches of gravel, 4 inches of sand, and 10 inches of soil. Various rocks, sands and soils have been studied in our laboratories for water holding capacity, drainage, and general suitability. Antioch fine sand found extensively on Alameda Island appears to meet all of the requirements better than any other soil examined.

VETERINARY SCIENCE

The Abortion Agglutination Test in Relation to the Disharge of Bact. abortum from the Bodies of Cows.—Investigations of this phase of the abortion problem have been carried on throughout the year in the University Farm dairy herd by F. M. Hayes and E. H. Barger. The main objectives sought were two-fold: (1) to study the relationship that may exist between the presence or absence of agglutinins in the blood and milk and the presence of infection as indicated by the discharge of *Bact. abortum* through the milk or genital passages, and (2) to determine from this relationship whether the agglutination test alone can be depended upon to identify all of the infected animals so that their removal from the herd would control or eradicate the disease.

To accomplish the objects indicated above regular agglutination tests have been made simultaneously with blood serum and milk upon all of the dairy cattle in the herd. The milk was also examined for the presence of *Bact. abortum*. In addition, aborted fetuses, placentae, and uterine discharges have been studied for the abortion organism.

The results of the agglutination tests upon the blood serum and milk and of the study of the milk for the presence of *Bact. abortum* were as follows:

Number of persistently negative mature cows	35
Number of persistently positive mature cows	15
Number changing from negative to positive	3
Number changing from positive to negative	1
Number of mature cows positive in blood serum only	5
Number of mature cows positive in milk serum only	0
Number of mature cows positive in both blood and milk	10
Number of mature cows positive in milk and discharging *Bact. abortum*	7
Number of mature cows positive in milk and not discharging *Bact. abortum*	3
Number of mature cows negative in milk and blood and discharging *Bact. abortum*	1
Percentage of mature cows positive in either blood or milk and discharging *Bact. abortum* in milk	46
Percentage of mature cows positive in milk and discharging *Bact. abortum*	70

A study of the records from which the above data were compiled suggests the following tentative conclusions:

1. In every case in which *Bact. abortum* was isolated from the milk, the milk gave a positive reaction, but we were unable to isolate *Bact. abortum* from every case in which the milk was positive to the agglutination test.

2. There apparently is no direct relation between the agglutinin content of the blood and that of the milk, since a few of the cows positive in blood were not positive in milk, and in most cases where blood and milk both were positive the milk showed a lower titre.

3. In most cases in which *Bact. abortum* was isolated by the plate culture method, the organisms were present on the plate in large numbers.

4. Agglutinins may be present in the milk of cows that have aborted and in the milk of cows that have never actually aborted.

5. Periodic agglutination tests upon the blood serum will identify practically all the "carriers" in as much as no cow was positive consistently in the milk and not in the blood, although *Bact. abortum* was found once in the milk of a cow which had been negative in blood and milk at every test. Furthermore, *Bact. abortum* has not been found discharged from the genital passages at parturition in cows negative in blood. On the other hand the organism was found discharged from the genital passages of two of the three cows positive to the agglutination test; the material from the third cow was too decomposed for satisfactory examination.

6. The success in controlling abortion in some herds by the removal of the blood serum reactors seems to be based upon sound scientific data and is to be recommended in herds where the infection is not too great.

Bacterium abortum Isolated from the Faeces of Suckling Calves.—A discovery of some practical significance was made by Roscoe Clowes, a senior student under the direction of E. H. Barger and F. M. Hayes, in an experiment to determine whether calves drinking milk artificially infected with *Bacterium abortum* discharge the organisms in the faeces.

Two bull calves, less than a week old at the beginning of the experiment, were fed twice a day with milk from a healthy cow. To each feed of milk was added 10 mils of a suspension of a fresh agar slant culture of *Bacterium abortum.* The growth on each culture was washed down with 20 mils of salt solution and one-half of this amount fed at each of the two feedings. No other food was allowed the calves. They were kept entirely separate from other calves and fed from different utensils. The blood of the calves remained negative to the abortion agglutination test throughout the thirty-seven days that they were fed abortion organisms.

At intervals of three or four days for five weeks, one gram of faeces was withdrawn from the rectum of each calf by means of a sterilized wooden curette. The gram of faeces was shaken in sterile salt solution and a dilution of 1-1000 prepared. One and one-half mils of this filtered dilution, representing the organisms in 1.5 mg. of faeces were injected subcutaneously into guinea pigs. The guinea pigs which were inoculated from each calf on the 16th, 19th, 23rd, and 26th days all became infected and *Bacterium abortum* was subsequently isolated in pure culture from their tissues.

In the ordinary control of abortion little attention is usually given to the separation of suckling calves from surroundings which they might contaminate with their infected faeces, if, in fact, their faeces do contain *Bacterium abortum.* The most important principle in the control of abortion at the present time is to identify all animals that might be discharging the organism. Most of the sources of elimination of abortion bacilli from an infected cow are well known, but the practical significance of Mr. Clowe's discovery relates to the part which the calf drinking infected milk may play in contaminating premises by its intestinal discharges.

Controlled Vaccination Experiments on Cattle with Bacterium abortum.—An investigation at Berkeley designed to furnish information on the important question of the actual value of live organisms in producing immunity has been in progress during the year.* Twenty animals were vaccinated and infected in order to demonstrate the value of the vaccine in preventing abortion. Only seventeen of this group, however, became pregnant. At the same time ten other

* For an outline of this project see page 280, Bull. 353, Calif. Agr. Exp. Sta.

animals were similarly vaccinated, but were prevented from having access to any further infection in order to ascertain how long the injected bacteria would remain in the bodies of vaccinated animals. Only four of this group became pregnant.

Ten animals, all pregnant, not previously exposed to infection in any way, were placed with the first group and were subjected to the same infection. These were the control group in the experiment. The infection in these cases was given at one time only, by the mouth, and consisted of naturally infected milk, salt solution emulsion of tissues from aborted fetuses containing *Bact. abortum* and laboratory cultures of the organism.

Following the infection, six of the controls aborted in from 58 to 88 days; one calved in 10 days, too soon for infection to have occurred; one gave birth to a male calf 28 days after infection, and her membranes and milk contained the organism; and 2 calved normally at term on the same day, 162 days after the infection.

All of the seventeen pregnant animals which had been vaccinated and infected, calved normally at term except one which was accidentally killed in the last month of gestation, and one which calved at term with a fully developed calf born dead. The pregnancy in the animal accidentally killed was progressing normally.

The four animals in the ten head that were vaccinated and not infected, all calved normally.

This experiment demonstrated definitely the protective value of live abortion germ vaccine in the prevention of abortion. It also demonstrated the ability of *Bact. abortum* to produce this phenomenon when given to susceptible animals by way of the mouth at a single exposure.

The fact that only twenty-one of the thirty vaccinated animals became pregnant, while all of the controls did so, leads to the possible conclusion that the injection of the vaccine into virgin heifers may have some effect on the estrous cycle and tend to prevent conception.

A detailed report of these experiments to date is being prepared for publication.

Equine Infectious Anemia.—In the summer and fall of 1922, an epidemic occurred which caused severe losses in horses in the Honey Lake Valley in Lassen County, and for which no positive diagnosis had been established. At the request of the Farm Bureau of the county, an investigation was made by G. H. Hart in November, 1922. Several affected animals were available for examination and the clinical information thus obtained, together with the history of the outbreak, caused the presence of swamp fever to be suspected.

This valley is on the eastern side of the Sierras, close to the Nevada line, and horses had been brought into the territory from parts of Nevada where the disease was known to exist. An extensive study of the disease had been made by the veterinarians of the Nevada Station and, as this was close to Reno, they were asked to send a man into the territory. Dr. Stephen Lockett, Field Veterinarian for the Station, answered the request. With his coöperation, one post mortem examination was made. Quite characteristic lesions of the disease were found in the liver and bone marrow. Blood was collected from three affected horses, defibrinated, and injected into one experimental horse obtained at Susanville, outside the affected area. This animal failed to develop the disease. None of the affected horses were in the febrile stage at

the time blood was taken, and inoculation experiments are not always successful under such conditions.

As usual, this malady has caused little difficulty during the winter. The disease has not been reported heretofore in California. The area in which the epidemic occurred is quite isolated, and a large number of the horses in the district were killed off by it. As a consequence, we do not feel that there is great danger of its spreading.

Ictero-Hemaglobinuria or Red Water Disease in Cattle.—This continues to be a source of loss among cattle in various parts of the state. At the request of the Northern California Counties' Association, a field laboratory was established in the summer of 1922 at Etna Mills in Scott Valley, Siskiyou County, to make a study of this disease. The valley is remotely situated, and has no resident veterinarian. It was the general opinion that in many instances owners attributed to this disease sickness and losses that were really the result of other non-specific disorders.

The disease was not very prevalent during the period of the investigation, but between twenty-five and thirty cases were observed by H. Phipps during the time he was employed by this Station, June 1 to September 15. Two affected animals were each given 400 mils of *B. oedematiens* serum intravenously, but no beneficial result was observed, the animals dying in seven and twenty hours, respectively, after its administration. Five cases were each given intravenously 200 mils of non-specific serum in the form of Botulinus antitoxin, but all of these cases resulted fatally in from a few hours to five days following the treatment.

One hundred and seventy-nine animals were vaccinated with *Bact. Welchii* aggressin, one hundred with hemorrhagic septicemia bacterins and twenty-two to be used as checks, not treated. The one hundred head were really controls also, as the hemorrhagic septicemia bacterins have not been demonstrated to have value in preventing this disease, and were inoculated only at the urgent request of the owner. Two apparent cases of the disease developed in animals receiving the *Bact. Welchii* aggressin, but both recovered with symptomatic treatment.

It is difficult or impossible to make a definite diagnosis of the disease on anti-mortem examination in the absence of hemoglobinuria. A bacteriological examination was made of the tissues of several fatal cases, but no definite results were obtained.

A number of cases which were attended by H. Phipps and which the owners believed to be this disease recovered with symptomatic treatment, such as saline purgatives and stimulants. A positive diagnosis of the disease could not be made in these cases.

Treatment of Ascariasis in Hogs with Carbon Tetrachlorid and Oil of Chenopodium.—During January, 80 shotes at the hog barn began to show evidence of infestation with *Ascaris lumbricoides.* They were divided into two groups of 56 and 24 head, respectively. After twenty-four hours without food, each group received treatment. Group I was given 1 dram of oil of chenopodium, 1 dram of spirits of turpentine, and sufficient castor oil to make 2 ounces. This mixture was administered slowly on the back of the tongue by a two-ounce dose syringe, to the nozzle of which was attached a piece of rubber tubing. Two or three of the shotes in this group vomited in from thirty minutes to one hour after the treatment was given. None was hungry for the evening meal. In from eighteen to twenty-four hours the ascarids began to be passed with the faeces,

some of the hogs passing large quantities of worms. Twenty-four hours after the treatment, the appetite of these pigs returned, and they appeared normal.

Group II, consisting of shotes weighing from 70 to 125 pounds, was treated with 10 c.c. of carbon tetrachlorid in sufficient castor oil to make 2 ounces. This treatment was administered in the same manner as the chenopodium and turpentine mixture. Within thirty minutes all pigs in this group showed symptoms of illness by the appearance of dullness and a desire to bury themselves in the litter. None would eat the evening feed. The following morning ten of the twenty-four were dead, including eight weighing approximately 75 pounds each and two weighing 125 pounds each. Autopsies were performed and characeristic lesions noted upon all the dead hogs. In those hogs of this group that did not die, there was no evidence that carbon tetrachlorid was an effective vermifuge. According to the weight of the pigs, the amount given was exceedingly small, being less than one-fifth of the dose prescribed by M. C. Hall.* It is evident from our results that carbon chlorid is not a safe drug to give hogs for the removal of ascarids.

Deaths of Baby Pigs.—At several garbage feeding plants, where part of the pigs were raised from garbage-fed sows, serious losses were sustained in the pigs during the first few days of life. A considerable number of the pigs that survived this period were lost between the ages of three and six weeks from white scours. The first indication of sickness in the pigs was observed two days after birth. They stood apart from the remainder of the litter, with nose to the floor, hair erect, later being unable to stand and passing into a comatose state. Death occured about the fourth day.

The postmortem examinations showed evidence of navel infection in all cases. It was recommended that the sows' teats be washed before farrowing with 3 per cent solution of cresol, and that the walls, posts, ceilings, floors, and troughs be sprayed with the same solution. The navel was to be cut off and disinfected with tincture of iodine at or immediately after birth. All this was done but failed to stop losses.

It was then noticed by Robert Jay, Federal coöperating Agent of the United States Bureau of Animal Industry, that when a part of an affected litter was given to a sow whose pigs did not show sickness, these pigs remained well. This fact suggested that the condition was due to intolerance of the milk rather than to infection of the navel. A system of feeding the sows was advised whereby they were not allowed any feed for from twenty-four to forty-eight hours after farrowing. Then, a feed of bran or a very light feed of garbage, consisting mostly of leafy vegetables, was given and the sows' feed gradually increased, taking two weeks to bring them on full feed. If, at any time, the pigs of a litter showed scours or sickness in any way, a portion of the feed was withheld for a day or two until the pigs were normal. Through this system of feeding the sows, together with sanitary measures, the losses in pigs have been practically eliminated.

The University Certified Dairy at Berkeley to Close July 1, 1923.—The history of this dairy dates back to 1902, when eighteen head of cattle of differnt breeds were purchased and a barn built to be used for instruction in dairying and animal husbandry. In 1906 the University Farm was purchased and in 1909 instruction

* Hall, Maurice C., and Schillinger, Jacob E. Miscellaneaus tests of Carbon tetrachlorid as an anthelmintic, Jour. Agr. Research, vol. XXIII, no. 3, pp. 176–77, 1923.

was started at Davis. On July 1, 1910, the only member of the Animal Husbandry Division residing at Berkeley resigned, and C. L. Roadhouse, in the Division of Veterinary Science, took over the supervision of the dairy. An application was placed with the Alameda County Medical Milk Commission for certification, and distribution of certified milk began about September, 1910. The thirteen animals milking at the time were increased to twenty-four. This increase in numbers put the dairy on a self-supporting basis, a condition which has obtained ever since.

For years the dairy was used as a demonstration in the production of high-quality milk and for student instruction in a course given the fall semester on Dairy Bacteriology and Sanitary Milk Production, this course being taken by public health as well as agricultural students. It also furnished clinical material for the course in Elementary Veterinary Science given the spring semester. With the development of the Dairy Industry Division at Davis and the longer period of time spent by the agricultural students at the University Farm, the Elementary Veterinary Science course was discontinued at Berkeley and the dairy instruction in the Division of Veterinary Science stopped with the opening of the fall semester in 1920.

Since that time a study of the breeding history of the animals has been going on and the herd is now known to be free from infection with the *Bact. abortum* organism.

The buildings used by the dairy no longer represent up-to-date methods of construction. The supply of certified milk produced by commercial certified dairies is ample for the demand.

Certain abortion investigations have been carried on during the past biennium at the Stanley Ranch, which should be repeated in part and extended on adult cows with a known breeding history. It is, therefore, intended to cease certification of the dairy on July 1, and thereafter to utilize the animals, buildings, and land in abortion investigations.

Fate of Bovine Tubercle Bacilli in Chickens.—In an experiment by J. R. Beach, J. Traum, and J. C. Corl, eight ounces of pulmonary bovine tuberculosis lesions were mixed with the feed for twenty chickens on two successive days. Two guinea pigs inoculated with this material developed generalized tuberculosis. Three chickens inoculated subcutaneously and three intraperitoneally with this material were not affected. None of the birds fed showed any evidence of tuberculosis when killed and autopsied, thirty to sixty days later. Guinea pigs were inoculated with the night faeces of these birds collected on the first, second, fifth, twenty fifth, and thirtieth days after feeding the tuberculous material. No evidence of tuberculosis was found in any animal when killed and autopsied fifty to sixty days later.

A second experiment to determine the fate of bovine tuberculosis organisms when fed to chickens was made by J. Traum and J. R. Beach. Nine mils of pulmonary bovine tuberculosis material containing immense numbers of organisms were introduced directly into the crop of each of four chickens. Two guinea pigs inoculated intramuscularly with this material died of generalized tuberculosis in seventy-six days.

The droppings of the chickens were collected on the first, second, and fourth days after feeding, treated with sodium hydroxide or antiformin and injected intramuscularly into guinea pigs. None of the twelve animals injected showed any evidence of tuberculosis when killed and autopsied sixty-three to sixty-six

days later. The four birds fed were killed and autopsied ninety days later. No evidence of tuberculosis was found.

J. C. Corl and J. R. Beach observed a severe outbreak of tuberculosis which caused a loss of about 10 per cent of a flock of 900 pullets before they were fifteen months old. There had been but fifteen other birds on the place for two years previous and none of these had died. They were all disposed of when the 900 pullets were brought on the place at the age of three months. Such severe losses from tuberculosis in flocks of this age are unusual.

Chicken-pox (Epithelioma contagiosum).—The amount of chicken-pox vaccine used by poultrymen continues to increase. During the year ending April 30, 1923, 444,292 doses of vaccine and 139.5 grams of virus were distributed. All of the virus and 8210 doses of vaccine went to other states.

Field tests of the vaccine, in which approximately half of the healthy birds were vaccinated and the remainder not vaccinated (controls), were made in sixteen flocks by J. R. Beach. The results show that, while a considerable percentage of fowls vaccinated were not protected against chicken-pox, there was a sufficient difference between the number of diseased among the vaccinated fowls and the controls to make the use of vaccine in flocks affected with chicken-pox worth while. This is especially true since the cost of the procedure is so low.

*Fowl Cholera Associated with Ruptured Yolk.**—Further studies of this disease have been made by J. R. Beach. In one experiment, five hens were inoculated subcutaneously and five orally with *Bact. avisepticum* and the abdominal cavity of three birds of each group opened and a yolk ruptured by pricking with a sterile scalpel. Two of the three birds which had the subcutaneous inoculation and a yolk ruptured, and one which had the oral inoculation and a yolk ruptured, died. *Bact. avisepticum* was recovered from the heart, liver, and abdominal cavity. The remaining birds of these groups showed no ill effects from the inoculation and the rupturing of the yolk and were killed. Bacteriological examination was negative. One of the two hens inoculated subcutaneously but in which a yolk was not ruptured died. Ruptured yolk was found and *Bact. avisepticum* recovered from the heart, liver, and abdominal cavity. All other birds that did not have a yolk ruptured showed no ill effects from the inoculation and were killed. Bacteriological examination gave negative results.

In other experiments sixteen laying hens were inoculated subcutaneously with *Bact. avisepticum.* Three of these became sick. One died on the third day and two were killed. Ruptured yolk was found in the abdominal cavity of all three. *Bact. avisepticum* was secured in cultures from the heart, liver, abdominal cavity, and the yolks of the hen which died, and from the abdominal cavity and yolks, but not from the heart or liver, of the two that were killed. None of the others showed any ill effects from the inoculation and were killed. Some evidence of ruptured yolk was found in the abdominal cavity of five. *Bact. avisepticum* was recovered from the abdominal cavity, yolks, and ovary of one. Bacteriological examination of the others was negative.

Other experiments were designed to study the combined effect of oral or subcutaneous inoculation of laying hens with *Bact. avisepticum* and feeding an excess amount of protein. Three groups of fourteen fowls each were fed a high

* Report of the College of Agriculture and Agricultural Experiment Station, University of California, 1921–22, pp. 171–172.

protein ration and three groups a normal ration. One group of fowls on each ration was inoculated subcutaneously, a second group orally, and a third group used as a control, not inoculated.

Twenty of the twenty-eight fowls inoculated subcutaneously became sick and seventeen of them died. Ten of these were from the group on the high protein ration and seven from the normal ration group. All of these deaths resulted directly from the inoculation, not from the ration. Ruptured yolk was found in six. *Bact. avisepticum* was recovered from the heart, liver, and ovaries of ten and from the abdominal cavity, yolk and ovaries of three. Five of the fowls inoculated orally died, three from the high protein group and two from the normal ration group. Ruptured yolk was found in two of the fowls from the high protein group and both ruptured yolks and *Bact. avisepticum* in one of the fowls from the normal ration group, but not in the others. The control groups remained normal. The egg production of the high protein groups was much greater than those fed the normal ration. A bacteriological examination of twenty-five eggs from each group for the presence of *Bact. avisepticum* gave negative results.

Edema of the Wattles.—C. D. Carpenter isolated *Bact. avisepticum* from edematous wattles of a cockerel and a hen. The cockerel died but the hen appeared otherwise normal and recovered. Cultures of both strains, when injected into the wattles of four normal cockerels, produced an edematous swelling of the wattles in eighteen hours and death in four to six days. *Bact. avisepticum* was recovered from the wattles, heart, liver, and spleen of all birds.

Cultures of three other strains of *Bact. avisepticum*, isolated from hens with ruptured yolk, when injected into the wattles of normal cockerels produced edema of the wattles and death in two to six days. *Bact. avisepticum* was recovered in all cases.

Cultures of eight other strains of *Bact. avisepticum*, isolated from hens with ruptured yolk, failed to produce either edema of the wattles or death when injected into the wattle or subcutaneously.

In other naturally occurring cases of edema of the wattle, *B. coli*, *B. pyocyaneus* and *Staph. albus* (three strains), have been isolated. The injection of cultures of these organisms into the wattles of normal cockerels gave negative results.

Coccidiosis.—Studies of coccidiosis were made by J. C. Corl and J. R. Beach. Feeding chicks with fresh contents of the ceca of diseased chicks containing large numbers of oocysts failed to cause the disease. When, however, such material was kept moist and incubated until sporocysts developed, fatal coccidiosis could be readily reproduced in chicks fed with it. Thirty-six hours' incubation at 80° F. and seventy-two hours at room temperatures (55°–65° F.) were required for full development of sporocysts. Oocysts kept moist and incubated for ten days were still infective. Chicks fed with oocysts after twenty-five days' incubation were not affected. Oocysts, air-dried at room temperature for twenty-four hours and then moistened and incubated, developed sporocysts but failed to sporulate when dried for forty-eight hours or longer. Fresh oocysts, placed on the moist surface of soil in a shady place, failed to sporulate in thirty-five days (temperature, max. 69°, min. 25° F.). Oocysts, placed on moist soil exposed to sunshine during the same period, began sporulation in twenty-five days. Another portion of the same material, placed on soil and covered with a beaker, developed sporocysts in eight days.

Meriozoits were frequently found in bloody cecal contents of dead chicks. Marked motility was observed in the meriozoits from chicks autopsied immediately after death. Feeding chicks cecal contents containing large numbers of meriozoits did not produce disease.

Death from acute coccidiosis in chicks from less than one to four weeks old has repeatedly occurred on the sixth day following feeding oocysts containing sporocysts. Mature oocysts have been found in the ceca of chicks as early as six days after inoculation.

Buttermilk, sweet skim-milk, condensed whey (1 gram to 16 mils water), hydrochloric acid (1 mil to 250–300 mils water), bismuth subnitrate (200 mg. per chick per day), potassium dichromate (1–4000 solution), sulphocarbolate and mercuric chlorid compound (1–800 solution), powdered crude catechu (1–4000 solution), and powdered ipecac (33 to 200 mg. to the chick daily) were used in a series of coccidiosis control experiments.

The chicks used were transferred direct from the incubator into clean houses with tight board floors and were never allowed to run outside. At the age of one to three weeks they were infected by the introduction into the crop of 5000 to 10,000 oocysts containing sporocysts. As a control on any infection that might be present in the houses, two to four non-infected chicks were included with each lot infected. A control pen of infected chicks which received no treatment was included in each experiment. Treatment was started on the day the chicks were infected.

The losses from coccidiosis with the various methods of treatment were as follows:

Buttermilk	21.3 per cent
Sweet milk	18.6 per cent
Condensed whey	21.8 per cent
Hydrochloric acid	30.1 per cent
Bismuth subnitrate	38.3 per cent
Potassium dichromate	38.7 per cent
Sulphocarbolate and mercuric chlorid compound	45.3 per cent
Catechu	46.3 per cent
Ipecac	60.9 per cent
Control pen (infected but not treated)	40.7 per cent
Control chicks (non-infected chicks with each lot infected)	0.0 per cent

Practically all losses from coccidiosis occurred between the sixth and fifteenth days after inoculation. The chicks fed buttermilk or sweet milk weighed from 11.5 per cent to 96 per cent more than those of any other lot at the termination of the experiments. Thirty-three of the infected chicks which did not die were re-infected. None of these died. Forty-seven of the non-infected controls which had been kept in the same pens with them were infected. Thirty-four per cent of these died from coccidiosis.

Other Activities.—Eleven hundred and forty-two inquiries regarding diseases of poultry, and seven hundred and thirteen specimens for examination were received at the Berkeley office of the division. Three hundred and seventy-seven calls for advice and eight hundred and two fowls for examination were received from poultrymen at the Petaluma Laboratory.

VITICULTURE AND FRUIT PRODUCTS

New Experiment Vineyard.—All the plantings of 1921* developed rapidly and recovered completely in most cases from the effects of the frost of the autumn of 1921. A few varieties were injured in a similar way by the autumn frost of 1922. The only serious injury was done to the Henab which, like the Tokay, seems peculiarly sensitive to early winter frosts.

In the spring of 1923 the following new plantings were made:

1. Block H in Vineyard VI was set with 305 Black Prince and Muscat vines, to test the influence on crop and quality of varying densities of planting 302, 435, 605, 1210, and 2722 vines to the acre and of varying arrangements of the vines 4 by 4, 6 by 6, 8 by 9, 10 by 10, 12 by 12, and 3 by 12, 6 by 12, 2 by 18, 4 by 18.

2. Block F in Vineyard VI was planted as a duplicate of Block E to test the relation of winter pruning to the vigor of the vine, because the results of the first three or four years are rendered uncertain in Block E by the severe frost injury of the first year.

3. The four blocks of resistant mother vines in Vineyard VII were dug up and replanted because of the uneven stand obtained in the first planting.

Cordon Pruning.—The principal beneficial effects of the horizontal cordon system of pruning vines expected are:

(*a*) Larger crops, due to the increased extent of the vine.

(*b*) Improvment of the quality due to a better distribution of the bunches.

(*c*) The possibility of shorter pruning due to increased fruitfulness of the lower buds.

These expectations have been generally realized in practice by those growers who have bearing Emperor cordons in good condition.

To have some exact experimental evidence on some of these points, a test was made by F. T. Bioletti in a six year old vineyard of Emperor pruned by the unilateral horizontal cordon system. Ten adjacent vines, alike in vigor and size, were chosen in each of three adjacent rows. On one row the spurs were pruned back to the base, the first, or the second bud according to the vigor of the cane. On another they were pruned back to the first, second, or third buds; and on the last, to the second, third, or fourth.

While the vines were in blossom, the number and position of the blossom bunches were noted, and when the crop was harvested the weight of extra fine bunches of fruit ("drum stuff"), the weight of ordinary "crate quality," and the weight of fruit that was not harvested owing to the car shortage were taken for each row, with the results shown in the following table.

* Report of the College of Agriculture and Agricultural Experiment Station, University of California, 1921–22, p. 76.

PERCENTAGE OF SHOOTS WITH NO BUNCH, WITH A SINGLE BUNCH, AND WITH TWO BUNCHES OF BLOSSOMS—MAY 6, 1922—AND CROP HARVESTED, OCTOBER, 1922

							Crop—Pounds			
		D	B	a	b	c	DS	CQ	NS	Total
	0	41.4	28.0	16.7	......	......				
Short	1	44.8	60.0	50.0	38.5	53.2	120	165	60	345
	2	13.8	12.0	33.3	61.5	46.8				
	0	54.5	20.0	14.1	7.3	......				
Medium	1	45.5	58.2	37.2	29.3	......	130	140	40	310
	2	......	21.8	48.7	63.0	100.0				
	0	52.4	20.6	17.3	2.4	6.1				
Long	1	47.6	64.7	32.7	24.4	12.1	150	150	50	350
	2	......	14.7	50.0	73.2	81.8				

D=Dormant or adventitious buds from old wood.
B=Base bud; a, b, c, the order of the buds above the base bud.
O=No bunch; 1=one bunch; 2=two bunches.
DS=Drum stuff. CQ=Crate quality. NS=Not shipped.

Influence of Length of Pruning on Crop.—There is no perceptible influence of the length of spurs on the total weight of crop. Though the range of pruning was small, this result corroborates the opinion that the cordon system increases the fruitfulness of the lower buds.

Influence of Length of Pruning on Number of Bunches.—One hundred shoots on the short pruned vines produced 52 single and 54 double or a total of 106 bunches; on the medium pruned, 42 single and 79 double or a total or 121 bunches; and on the long pruned, 36 single and 95 double or a total of 131 bunches. These figures indicate that the buds near the base of the cane have less tendency to produce two bunches than those higher up.

Weight of Bunches.—As the number of bunches was smaller on the shorter pruned vines and the total crop about the same, the average weight of a bunch must have been greater. It was found that the average weight of a bunch on the short pruned vines was 3.2 pounds; on the medium pruned, 2.6 pounds; and on the long pruned, 2.7 pounds.

Quality.—There seems to be some influence on the quality of the grapes in favor of the longer pruning. The longer pruned vines yielded 25 per cent more fine clusters (''drum stuff''), and the medium pruned 11 per cent more than the short pruned. As this superiority of the fruit from the longer pruned vines was not due to the size of the bunches, it must have been due to color and quality of the berries.

Fruitfulness of Buds at Various Levels.—The buds nearest the base of the cane are usually, if not always, less fruitful than those several nodes higher up. The buds of an Emperor pruned to a low head are usually more or less unfruitful until the third or fourth from the base is reached. In systems of pruning which, like the cordon, elongate the trunk, the lower buds are more fruitful. By actual count of the number of blossom bunches from 100 shoots there were 45 single and 11 double bunches from the dormant buds; 61 single and 33 double from the base buds; 39 single and 90 double from the first buds; 28 single and 135 double from the second buds; and 25 single and 144 double from the third buds. These figures show that half of the shoots from old wood (from dormant and adventitious buds) may be fruitful on cordon pruned vines.

Fig. 113.—Young vine badly infected with Black Knot as a consequence of frost injury.

The fruitfulness of the buds increases rapidly here as we leave the base until we reach the bud at the second node, where it appears to be near the maximum. They indicate also that the fruiting shoots from old wood and base buds usually have only one bunch and that the number of shoots with two bunches gradually increases as we leave the base until single-bunch shoots are rare. This may account for the somewhat smaller size of the bunches on the longer pruned vines, but the decrease in size is more than offset by the greater number of bunches.

These experiments should be repeated, but they indicate that in pruning Emperor cordons, it is probably not wise to shorten the spurs too much, even though the lowest buds are fairly fruitful.

Comparison of Horizontal and Vertical Cordon.—Nineteen vines in a seven-year-old Emperor vineyard pruned by the common vertical cordon system were examined and compared with thirty vines in an adjoining six-year-old vineyard pruned by the horizontal cordon method. The following results were noted: Vines pruned by the horizontal cordon had from each 100 shoots an average of 56 blossom bunches from the dormant buds, 94 from the base buds, 129 from the first buds, 163 from the second, and 169 from the third. Those pruned by the vertical cordon showed 41 blossom bunches from the dormant buds, 104 from the base buds, 132 from the first buds, and 157 from the second.

These figures show that there is little difference in the fruitfulness of the buds of vines in the two systems up to the age of six or seven years. Any advantage of the horizontal system must be in the quality of the fruit and the permanence of the method.

Black Knot on Young Vines.—To prevent infestation of black knot on young vines that were frostbitten in autumn, L. O. Bonnet pruned them down to the uninjured tissue immediately after the frost. The pruning wounds were swabbed while fresh with a solution of one per mil. mercuric chlorid. In a block of 665 Muscat vines treated in this way not a single case of black knot was found, while in a row of 35 vines of Molinera pruned late and untreated, 90 per cent were infested with black knot.

Arrangement of Vines, Density of Planting, and Cordon Pruning.—F. T. Bioletti and A. J. Winkler have investigated the influence of these factors on the bearing and vigor of the raisin Muscat. The commonest arrangement of vines in a Muscat vineyard is 6 ft. by 12 ft. There would be advantages of convenience in having the rows farther apart. Experiments at Davis indicate, however, that there would be a loss in vigor and in crop.

Crop at 6 yr.	Vines planted, 6 by 12 head-pruned	5100 pounds
Crop at 6 yr.	Vines planted, 4 by 18 head-pruned	5160 pounds
Crop at 6 yr.	Vines planted, 3 by 24 head-pruned	4320 pounds

The use of the cordon system to counteract this loss in crop has been suggested. Experiments at Davis, however, indicate that the cordon on the contrary increases the loss.

Crop at 6 yr.	Vines planted, 6 by 12, cordon-pruned	4440 pounds
Crop at 6 yr.	Vines planted, 4 by 18 cordon-pruned	3900 pounds
Crop at 6 yr.	Vines planted, 3 by 24 cordon-pruned	3840 pounds

The number of vines to the acre (density) is the same in all cases. The figures indicate, therefore, that widening the rows from 12 to 24 feet decreases the crop about 15 per cent, and that the cordon system decreased it about 16 per cent.

Vigor.—The effect of the various arrangements on the vigor is similar to that on the crop, as indicated by measurements of the same vines. Comparative measurements of the stems were taken six inches above the soil in 1922 and in 1923. Vines planted 3 ft. by 24 ft. and cordon pruned showed an increase of 1.9 in., while those planted at the same distance and vase pruned showed a corresponding increase of 2.6 in. Vines planted 4 ft. by 18 ft. showed an increase of 2.2 in., cordon pruned, and 2.3 in., vase pruned. Those planted 6 ft by 12 ft. showed an increase of 1.6 in., cordon pruned, and 2.3, vase pruned.

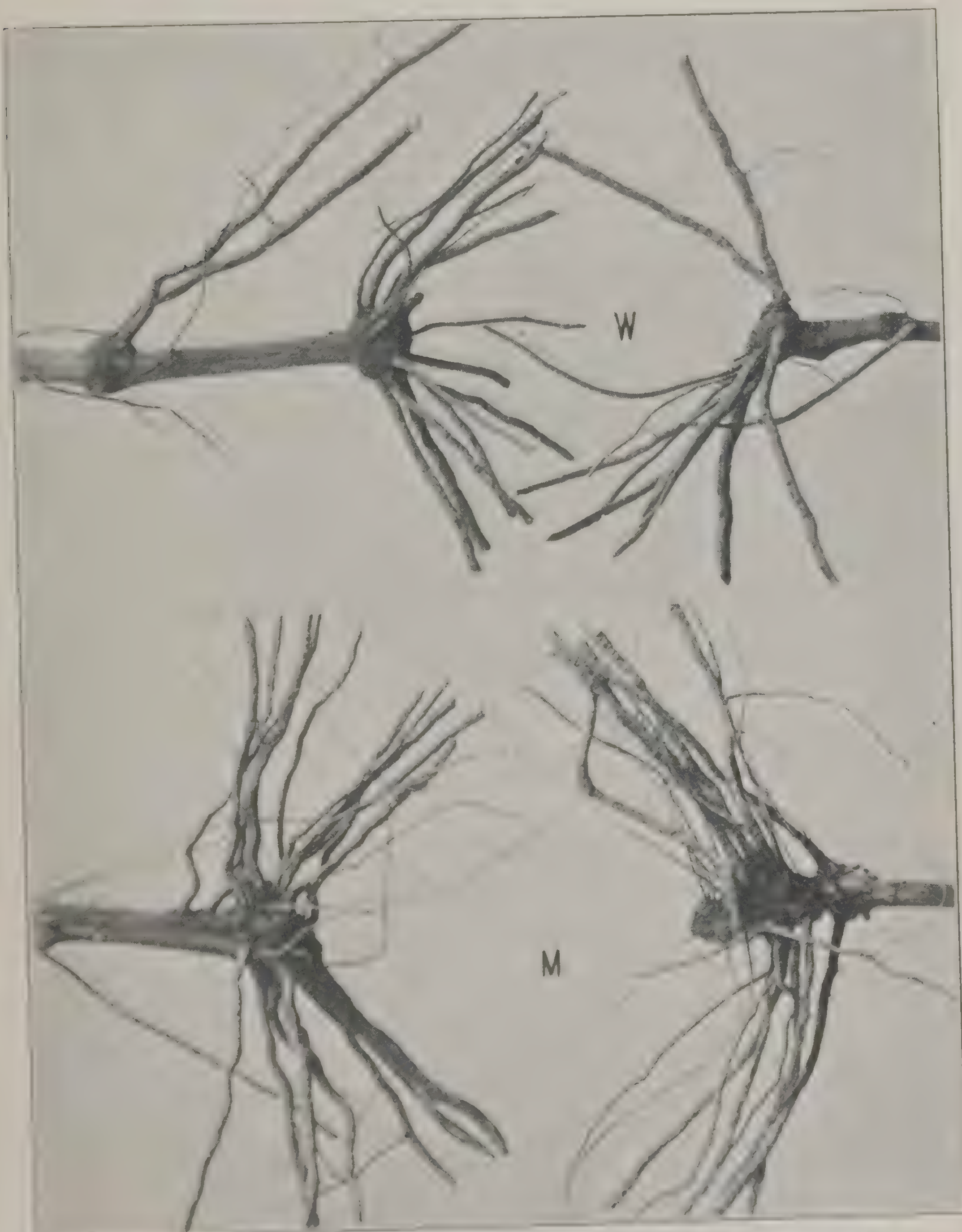


Fig. [illegible].—Rooting of Alicante Bouschet cuttings, one year in the nursery. W, Soaked two days in water before planting. M, Base immersed two days in two per cent $KMnO_4$ before planting.

If we accept the diameter of the trunk as a measure of the vigor of the vines, there is a very regular decrease of vigor with closer planting in the rows, a result which is not entirely counteracted by increasing the distance between the rows. This decrease of vigor is still further emphasized by changing from the head system of pruning to the cordon. The relative decrease of vigor is very regular, is in the same direction, and is of about the same amplitude as the decrease in crop.

The evidence presented by these figures indicates that a distribution of the vines as nearly regular as is possible is favorable to both bearing and vigor, and that the cordon system of pruning is unfavorable to the bearing and vigor of the Muscat under the conditions of the experiment vineyard at Davis.

Density and Cordon Pruning at Kearney.—Two lots of five-year-old Muscat vines grafted upon St. George roots growing in the experiment vineyard at Kearney yielded as follows:

Head pruned, 6 by 12 = 560 vines to the acre	9,350 pounds
Cordon-pruned, 3 by 12 = 1120 vines to the acre	18,150 pounds

The average crop of a vine in the 3 by 12 lot was 97 per cent of that of a vine in the 6 by 12 lot, but as there were twice as many vines to the acre, the acre crop was 84 per cent greater for the closely planted vines. This indicates that it might under some conditions be profitable to increase the number of Muscat vines to the acre, at least temporarily. The difference in acre crop would undoubtedly decrease as the vines grew older. There is no evidence that the cordon system was of any value in this case. There is little evidence, however, of the depressing effect noted at Davis. This was probably owing to better moisture conditions.

Preliminary Treatment of Vine Cuttings.—Experiments by A. J. Winkler have shown that the number and quality of rootings can be considerably increased by various methods of treating the cuttings.

Oxidizing Agents.—By immersing the base of cuttings in dilute solutions of various chemicals, such as $KMnO_4$, $MnSO_4$, H_2O_2, and others, the time required for the starting of roots was reduced. Not only was the root formation more rapid in the treated cuttings, but the number of roots produced was greater.

As indicated by the photographs (fig. 114) and by counts and measurements, the roots from cuttings immersed in the solutions were equal in size to those from cuttings immersed in water and were from 15 to 20 per cent more numerous. The chemically treated cuttings also included a greater number of first class rootings.

Selection and Callusing.—Cuttings as ordinarily made in the vineyard usually include some which are difficult to root and some which cannot be rooted. By selection before planting, some of the latter may be excluded, and by callusing the rooting of some of the former may be facilitated.

Tests of the effect of these two practices were made with the following results:

	Percentage of cuttings rooting
1. Without selection or callusing	51
(*a*) Cuttings appearing good (52 per cent)	62
(*b*) Cuttings which appeared doubtful (48 per cent)	38
2. Callused but without selection	61
(*a*) Cuttings appearing good (66 per cent)	59
(*b*) Cuttings appearing doubtful (34 per cent)	48

Selection by eye increased the probability of rooting about 10 per cent, and callusing had about the same effect. This difference is of considerable value in planting directly in the vineyard.

Position of Fruit Buds.—The fruit buds of a vine occur in different situations according to the variety and to growing conditions. By a microscopical study of the buds of Dizmar and Paykani, L. O. Bonnet has found that at Davis the lower buds on canes of these varieties are not fruitful. By modifying the pruning in accordance with his findings, he has been able to secure good crops.

Fig. 115.—Pruning tests of Dizmar. Contour vineyard laid out by the Division of Irrigation Investigations.

Similar results have been obtained by J. D. Rogers and W. L. Rogers working under L. O. Bonnet with other varieties including Bish Baba, Askari, Persian 29, Dattier, Ohanez, Molinera, Olivette de Vendemian, Malaga, Tokay, Emperor, Cornichon, Sultanina, and Muscat.

Dizmar and Monukka.—Various pruning methods are being tested on these two valuable varieties by L. O. Bonnet. A plot of 274 vines of Dizmar is being pruned by twelve different systems of long pruning. This will serve as a school of long pruning and as a means of discovering the best method for this valuable table grape. The Monukka is being tested under five systems: vase, fan, and bilateral cordon with spurs, and fan and bilateral cordon with canes.

Pruning Root-Stock Vines.—The interest attached to this problem is growing as the phylloxera spreads and the demand for cuttings becomes more pressing. Two new methods of pruning for wood production are being tested by L. O. Bonnet in comparison with the usual method. At the second year,

vines as ordinarily pruned to an 18 inch head produced 29 per cent less brush than 24 inch high bilateral horizontal cordons and 57 per cent less than vines headed at the surface of the ground. The last method has produced the most wood suitable for bench grafting and for cuttings usable as rootings. The quality of the cuttings produced under the three systems does not vary appreciably in regard to starch content, but the cuttings are straightest with the low head system.

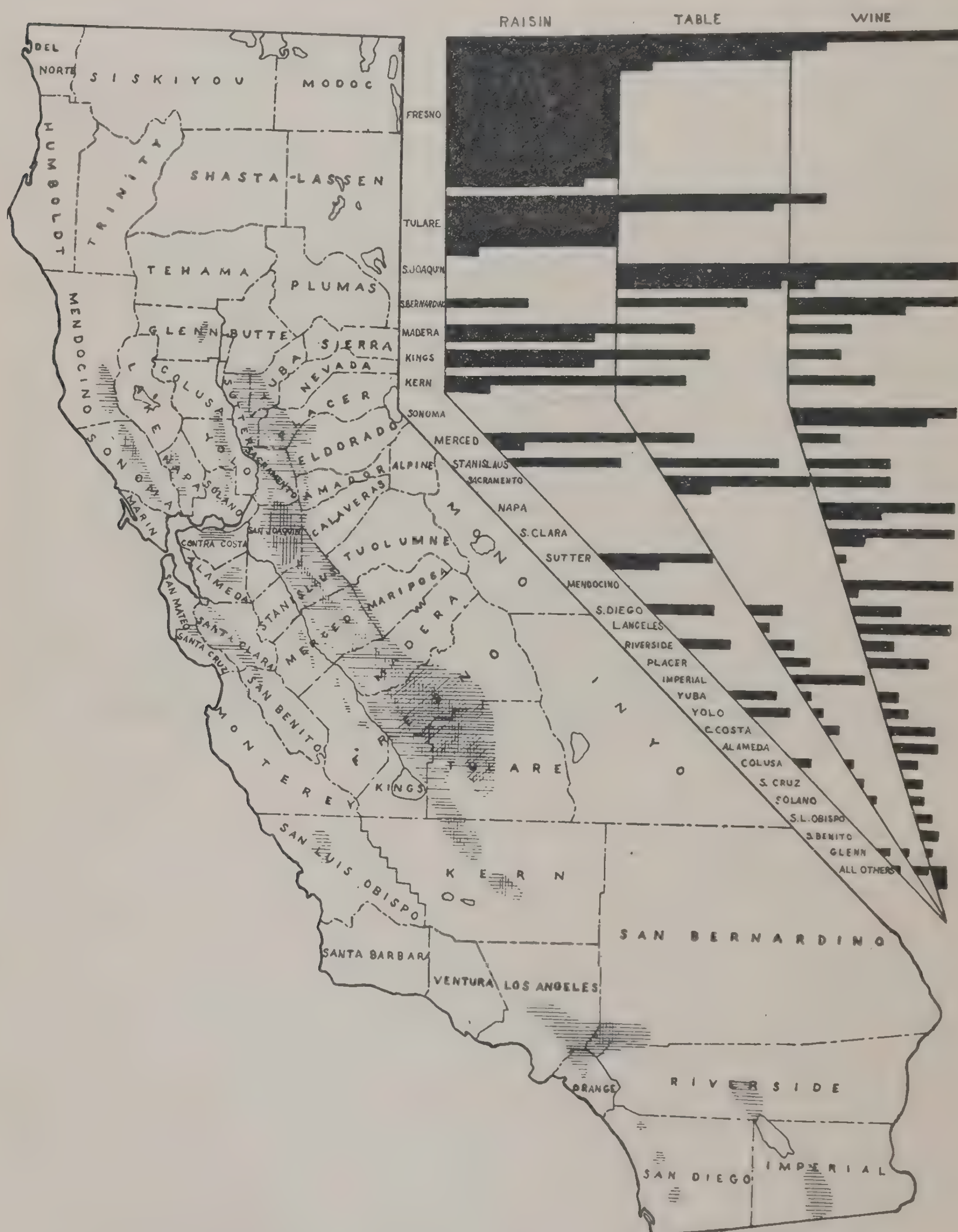


Fig. 116.—Distribution and extent of vineyards of raisin, table, and wine grapes in California.

In resumé: During the second year, mother vines pruned with a head at the surface of the ground produced more and straighter cuttings than vines pruned by either of the other systems. How much of this difference is due to the form of the vine and how much to the summer pruning needed to obtain the higher forms or to other factors will be made clearer by future crops of cuttings. Both the low vines and the wired cordons suffered less from wind damage in the spring than the vines of ordinary form.

Table Grape Investigations.—During the last decade there has been a great increase both in the acreage devoted to the growing of table grapes and in the number of new and inexperienced growers. The need of making general the methods of the best growers and of solving pressing problems is therefore very urgent. In the hope of contributing to this end H. E. Jacob and J. H. Herman made a survey of the methods and conditions in the principal table grape regions during the season of 1922. Their principal object was to determine in what way, by appropriate cultural methods, the grower could contribute to the quality of the grapes as they reached the consumer. With this object in view they made investigations in the Sacramento, San Joaquin, Coachella, and Imperial valleys. They visited and made reports on 30 packing houses and 102 vineyards.

Extent of the Industry.—The shipments of table grapes, which were less than 4000 carloads in 1908, increased to over 6000 in 1911 and to over 15,000 in 1922. The increase available for shipment will continue as the extensive new plantings come into bearing. It is estimated that there were about 50,000 acres of table grapes in the state in 1911. The acreage in 1922, according to the statistician of the State Board of Agriculture, was 136,600. Of this amount 50,182 acres were non-bearing. Increase of quality and decrease of cost are necessary if this great prospective increase is to be marketed profitably.

Influence of Cultural Operations.—Wide differences in practice were found in the methods of pruning, cultivation, irrigation, and all other cultural operations used by the growers, and in the methods of handling by the packers. Methods successful in one district were found unsuitable in others.

Methods of Packing.—Most of the grapes are packed in packing houses equipped for the purpose (fig. 117 and fig. 118), but a few are packed in the vineyard as they are gathered ("field pack"). The types of containers used are the crate with four chip baskets ("crate pack"), the "lug box" without baskets, and the drum or barrel with sawdust ("sawdust pack"), in which the grapes are surrounded by specially prepared sawdust.

The wide distribution of the table grape vineyards and their relation to the raisin and wine grape vineyards is shown by figure 116. Table grapes are grown from Shasta County to Imperial County, and from the cool coast region in Napa and San Diego counties to the hot interior in Kern and Imperial counties. This introduces many differences of soil and climate, which necessitate differences of cultural and packing methods. The differences in climate are indicated by figure 119. The rainfall ranges from 39 inches at Redding to 2.8 inches at Indio, and the annual sum temperature from 20,000 at San Diego to 26,400 at Imperial.

Fig. 117.—Packing house arrangement for "crate pack."

Fig. 118.—Packing house arrangement for "sawdust pack."

Fig. 119.—Rainfall and temperature in typical grape growing regions of California.

Fruit Products

Fruit Syrups—J. H. Irish reports that pomegranates are a very promising source of syrup for fountain and bottlers' use, since the discovery that a juice of deep red color, free from disagreeable astringency can be obtained by pressing the whole fruit. This juice is equal in quality to that obtained by the laborious and costly preliminary separation of peel and rag formerly considered necessary. Heating the juice to 140° F. to coagulate proteins and allowing it to settle twelve to twenty-four hours facilitates filtration and renders the juice permanently clear. Sweetening to 35° Balling with cane sugar gives a syrup of good flavor, not too sour when diluted for beverage purposes.

Berries yielded the most satisfactory syrups when harvested soft-ripe. Some syrups made from loganberries and other fruits rich in pectin formed a jelly when sweetened to 50° Balling or above. With such syrups 45° Balling should not be exceeded.

Further experiments have shown that concentration by freezing yields fruit syrups of better flavor than any other known process. A very simple method of applying the freezing process has been devised, as follows: The juice is allowed to freeze slowly at a temperature of 0–15° F. in large glass carboys, barrels or other suitable containers. The containers are then inverted and the syrup runs out, very little adhering to the ice crystals. A single freezing yielded a Muscat syrup of 43° Balling.

The rapid deterioration in flavor of citrus fruit syrups during storage has been the most serious obstacle to their commercial production. J. H. Irish has determined that the rate of deterioration can be greatly retarded by increasing the density of the syrups to about 70° Balling. W. V. Cruess and J. H. Irish applied flash pasteurization* to citrus juices and found that the keeping quality of the syrups made from them was greatly prolonged. Orange syrup made from such juice retained its flavor satisfactorily for more than twelve months.

J. G. Brown, a graduate student working under the direction of Cruess and Irish, has prepared from seeded Muscat raisins a syrup suitable, after blending with orange and lemon syrups, for the preparation of carbonated beverages. The name of "raisinade" syrup has been given to this product. Directions for the preparation of this syrup can be obtained free of charge on application to the Fruit Products Office, 336 Hilgard Hall, University of California, Berkeley.

Filtration of Fruit Juices.—In 1921 J. H. Irish reported that infusorial earth when used as an aid to filtration imparted a disagreeable flavor to juices. His more recent investigations have proved that a calcined infusorial earth, or infusorial earth thoroughly washed with water to remove its earthy taste, can be used satisfactorily. The juice is rendered brilliantly clear without injury to the flavor.

Two types of pulp filters have been used and found thoroughly satisfactory.

Carbonated Beverages.—The work on fruit beverages has been continued upon a semi-industrial scale by J. H. Irish during the past year (fig. 120).

* Flash pasteurization was first described by Dr. E. M. Chace of the Bureau of Chemistry, U. S. Department of Agriculture. It consists of heating the juice to a high temperature (180–212° F.) for a few seconds and immediately chilling it to room temperature.

Several fruit syrups prepared commercially have been found satisfactory in the preparation of bottled carbonated beverages. Among these are an orange oil concentrate from the Exchange Orange Products Company, San Dimas, and a red grape syrup from the National Fruit Products Company, Lodi.

About five thousand bottles of fruit beverages were made and distributed during the year. Most of them were sold in Oakland and Berkeley at various groceries and at industrial and University expositions. Many customers showed their appreciation by repeated purchase and demonstrated that the retail price of ten cents a bottle is not a serious barrier to the sale of real fruit beverages.

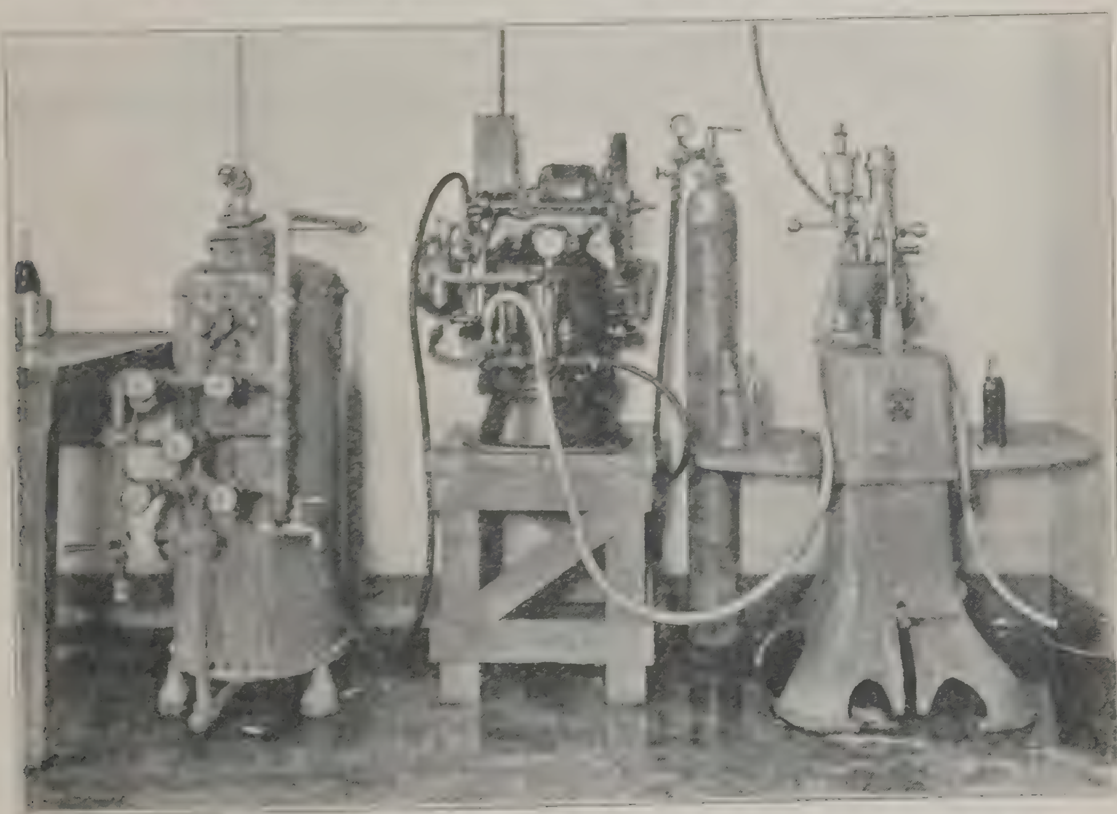


Fig. 120.—Water softening, carbonating and bottling equipment in the Fruit Products Laboratory.

Loganberry, raspberry, and orange beverages were most popular. Fruit punch and Muscat blend (red) were also well received and were preferred to strawberry and pomegranate.

Several commercial organizations are planning to manufacture fruit syrups and beverages by the methods we recommend.

Olive Pickling.—Extensive experiments by W. V. Cruess and L. H. Guthier (an advanced student) have confirmed the recommendations given in the 1921-22 Report of the Director* for the prevention of softening and floating of olives during pickling. In addition it was found that the trouble could be arrested in mild cases by treating the olives with a three-fourths per cent lye solution in the pits for several hours. Our recommendation† of pasteurization of the affected olives at 175° F. for thirty minutes was followed in a large factory with satisfactory results.

* Report of the College of Agriculture and Agricultural Experiment Station, University of California, 1921-22, pp. 182-183.

† *Ibid.*, pp. 181-182.

The Sevillano, Ascolano, and Manzanillo varieties of olives are much more susceptible than the Mission to fermentation and softening.

Fruits in Candy.—In further experiments on the use of fruit* in candy, dried fruits combined with concentrated orange pulp were made into very pleasing yet inexpensive candies as follows: The whole, unpeeled oranges were ground in a food chopper, mixed with an equal weight of sugar, concentrated by boiling to a very heavy jam, and then mixed with various dried fruits by grinding. Seeded Muscat raisins combined with the orange pulp gave a particularly satisfactory material for centers for chocolate coated candies.

Candied fruits tend to become too dry and flinty when stored in ordinary candy boxes. When sealed under a vacuum in glass jars they have remained fresh in flavor and of excellent texture and appearance for several months. This method of packing should greatly extend the territory for the sale of this product.

The investigations on the use of pectin, or of fruit juices rich in pectin, in preparing fruit candies, have been continued and expanded. Several hundred boxes of chocolate coated fruit jelly candies have been made and sold. The demand on the campus for these candies has been good.

One satisfactory formula for preparing the jelly centers is as follows: To four parts of any fruit juice, add one part by volume of concentrated pectin syrup such as 'Certo,'' and sugar equal in weight to that of the mixed juice and pectin syrup. Concentrate by boiling until a thermometer inserted in the boiling liquid indicates 225° F. Pour into small depressions of suitable depth and shape in a one and one-half inch layer of powdered dry starch and allow to solidify and cool for twenty-four hours. Separate from the starch by screening and dip in chocolate. This formula can, with slight modification, be used with fruit pulp or fruit syrup.

It is believed that the use of fruit in candy may afford a profitable outlet for a large amount of California fruits. The size of the candy industry is indicated by the amount of sugar used in commercially made candy, about 350,000 tons a year in the United States. At present very little candy is made from fruit, but confectioners are exhibiting rapidly increasing interest in fruit candies. The fruit candy investigations have been conducted by W. V. Cruess, J. H. Irish, and several advanced students.

Raisin Canning.—In the canning of seeded Muscat raisins two serious difficulties have been encountered, the raisins in some cases have fermented and in others have crystallized. Investigations by W. V. Cruess and W. B. Maher (an advanced former student) proved that the method of canning formerly in use so greatly increased the moisture content that yeasts were able to develop and cause fermentation in the unsterilized canned raisins. Sterilization of the raisins in sealed twelve and eight-ounce cans for thirty minutes at 212° F. was found to heat the raisins at the center of the cans to above 160° F. and render them free from living yeast cells and subsequent spoilage by fermentation.

Crystallization of grape sugar in the raisins is still under investigation.

Canned Fresh Prunes.—Large quantities of dried prunes are now canned in light syrup. Experiments were made by W. V. Cruess and J. G. Brown to determine the effect on quality of canning the fresh prunes without preliminary drying. The results were very successful. To check the skins and prevent bursting in the can, the prunes were dipped before canning in dilute boiling

* Report of the College of Agriculture and Agricultural Experiment Station, University of California, 1921–22, p. 184.

lye. They were canned in a light syrup (30° Balling); the filled cans were exhausted about eight to ten minutes in steam, and then sealed and sterilized thirty minutes at 212° F. Several hundred pounds of the fruit were canned in enamel lined cans and sold on the campus. The product was well received.

Canned Grape Fruit (Pomelo).—Great interest in the canning of grape fruit has been aroused among fruit canners in California by the success of canning this fruit in Porto Rico and Florida. At present the outer skin is removed by hand; the sections of the fruit are separated and peeled by hand. Experiments in the Fruit Products Laboratory have shown that the sections can be peeled by a dilute boiling solution of lye very quickly and economically with very great saving in time and labor. A two per cent lye solution was used.

Pear Spread.—It is estimated that about three thousand tons of cull pears were produced in the Sacramento Valley last year. These were dried or consigned to the refuse heap. As dried pears they yield a poor product. A product developed in the laboratory which promises to become important commercially is "Pear Spread," for the manufacture of which cull pears are suitable. During the last fruit season two and one-half tons of cull pears were furnished by the Pear Growers' Association at a nominal cost and were made by J. H. Irish into "Pear Spread." The yield was about 1600 No. 1 tall cans. This was placed on sale in various stores in Berkeley and Oakland and at the laboratory. It has met with general approval, and there seems to be a demand for it. Commercial organizations have shown interest in this product.

Dehydration of Prunes.—The dehydration of prunes has been given specific study by A. W. Christie. Accurate cost accounts on several of the newest and most efficient dehydraters show that operationg costs for dipping and drying prunes as low as $3.50 to $4 a green ton are readily obtainable, while the fixed charges for interest, depreciation, insurance, and taxes need not exceed $2 a green ton in an efficient dehydrater operated at full capacity for the normal prune season.

In order to ascertain the compartive yields of dehydrated and sun-dried prunes a test was made at a dehydrater in Santa Clara County. One ton of uniform French prunes were lye-dipped and graded, ten 3 ft. by 8 ft. trays each of No. 1 and No. 2 sizes being obtained. Of each lot of ten trays, five were dehydrated and five sun dried, accurate weights before and after drying being recorded. Dehydration required 21 hours for No. 2 and 28 hours for No. 1 prunes, while sun-drying required 18 days, though the weather conditions were exceptionally favorable. After both lots were reduced to the same moisture content the average yield of each 100 pounds of green fruit was taken. No. 1, sun dried, averaged 42.7 pounds; while No. 1, dehydrated, averaged 46.3 pounds. No. 2, sun dried, averaged 54.2 pounds and No. 2, dehydrated, 54.9 pounds. The count showed an average of 43 prunes to the pound in the case of No. 1, sun dried, and 42 to the pound of No. 1, dehydrated. No. 2, sun-dried, averaged 47, and No. 2, dehydrated, 43.

These figures substantiate the opinions of several prune growers that dehydration results in greater yield and larger size because it prevents the loss in weight caused by fermentation during the slower sun-drying.

The effect of humidity on the drying rate and quality of dehydrated prunes was made the subject of laboratory experiments. Three portions of the same lot of prunes were dehydrated under identical conditions except that relative humidities of 10, 25, and 40 per cent were used at the finishing temperature of 165°. The counter-current system was used, the corresponding humidities of

the air at the fresh fruit entrance being 26, 60 and 90 per cent, respectively, at 135°. The accompanying graph (fig. 121), illustrates the relative rates of dehydration, each increase of 15 per cent in humidity adding two hours to the drying time. Samples of each lot, as well as of sun-dried prunes from the same trees, were cooked and served to some twenty persons for an opinion on the quality. The prunes finished at 10 per cent humidity received the largest vote, closely followed by the 25 per cent humidity lot, while those finished at 40 per cent humidity and those sun-dried were a distant third and fourth choice, respectively. It is evident from these results that rapid dehydration at a moderate temperature and humidity gives the best quality in prunes.

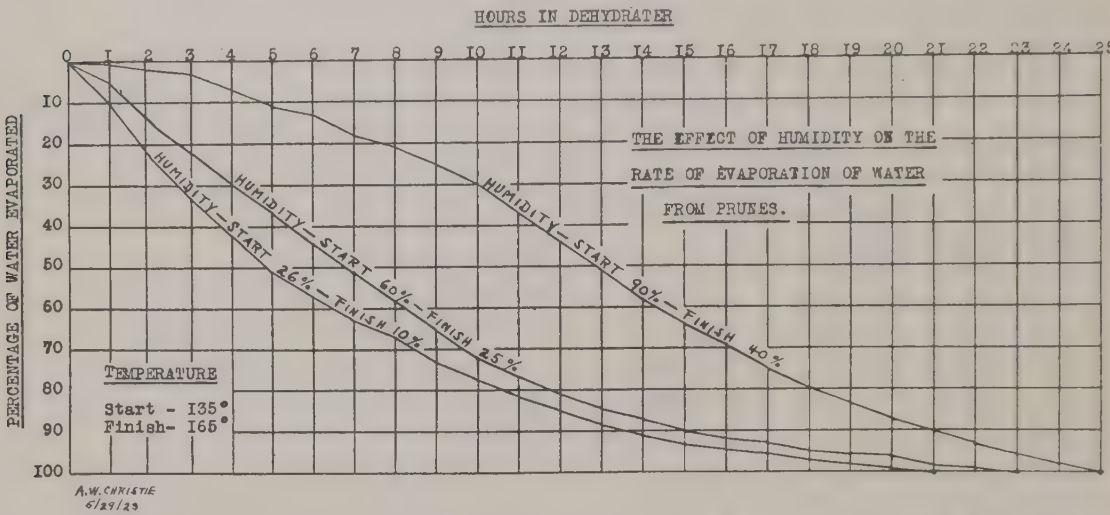


Fig. 121.—The effect of humidity on the rate of evaporation of water from prunes.

Dehydration of Walnuts.—A study of the principles underlying the artificial drying of walnuts was begun by A. W. Christie, assisted by E. H. Guthier. The results have been sufficiently encouraging to warrant a more detailed comparison of sun-drying and dehydration of walnuts in 1923 in collaboration with L. D. Batchelor. Freshly harvested walnuts were successfully dehydrated with the following average relation between temperature and drying time: 46 hours at 80° F., 19 hours at 100° F., 16 hours at 110° F., and 11 hours at 120° F.

The various lots of walnuts have been stored under observation since October, 1922. The nuts are in perfect condition, showing that dehydration at the above temperatures is not injurious and that it greatly hastens drying, especially in damp weather.

Dehydration Statistics.—A. W. Christie has compiled annual dehydration statistics for 1922. Forty-eight new dehydraters were erected and several older plants extended. Of the 180 plants in the state, 146 were operated and the tonnage of all products except pumpkin, which had a decrease of 94 per cent, was much greater than for 1921. The greatest increase in dehydration was in peaches, a tonnage of 2640 per cent greater being noted in 1922 than in 1921. Dehydrated grapes increased 1375 per cent; prunes, 353 per cent; apricots, 223 per cent; and pears, 216 per cent. Miscellaneous fruits dehydrated showed a growth of 50 per cent. These figures are undeniable proof of the successful growth of dehydration in California. While yet in its infancy, it is evident that this method of drying has been established on a firm basis which augurs well for its future development.

University Farm Dehydrater.—Under the supervision of A. W. Christie, assisted by E. H. Guthier, the following improvements were made at the University Farm dehydrater, and resulted in more rapid and more uniform drying of the fruit as well as in greater economy of operation:

1. Installation of a compressed air oil-burning system for heating the dehydrater furnace and the lye dipping vat.

2. Rearrangement of the furnace and flues to permit the use of either direct or indirect heating of the air.

3. Installation of a 15 horsepower motor for obtaining increased air flow from the fan.

4. Enlargement of the return air flue, connecting the fan discharge to the furnace room, to four times its former size, resulting in greater air flow and lower frictional resistance.

The dehydrater was operated for a total of 40 days, and 169 tons of fruit dehydrated, 25 tons by the Division and 144 tons of prunes and grapes by growers to whom the plant was rented. The preparation was as follows:

Apricots—Halved, pitted, washed, and sulfured.
Peaches—Halved, pitted, lye peeled, washed, and sulfured.
Pears—Hand peeled, cored, washed, and sulfured.
Prunes—Lye dipped and washed.
Grapes—Lye dipped and washed.

The maximum temperature used was 165° on apricots, prunes, and grapes; 155° on peaches; and 145° on pears. The dehydrated fruit was emptied from the trays into clean sweat boxes and tightly covered with paper. Within a few days the fruit was sealed in insect-proof cartons under the University Blue and Gold label, together with a printed slip explaining the source and method of preparation of the contents and requesting the consumer to report on the quality of the product to the Fruit Products Laboratory. These fruits are being successfully sold in a number of stores around San Francisco Bay, and, with few exceptions, have been well received. A detailed report on yields, costs of production, and marketing, is in preparation.

Packing of Dried Fruits and Vegetables.—Experiments on the packaging of dried fruits and vegetables and the control of insects infesting such products are being conducted by E. H. Guthier and C. E. Woodworth under the supervision of A. W. Christie. Woodworth has found that the optimum moisture content for the development of insects in dried prunes and apricots is about 18 per cent. A moisture content as low as 10 per cent or as high as 26 per cent prevented the development of the common dried fruit insects, but a moisture content of 26 per cent permitted the growth of mold in unsulfured fruits.

Comparative observations over a period of one year on dried fruits and vegetables packed in wooden boxes, paper cartons, and tin cans have been made by E. H. Guthier. Wooden boxes permit loss of moisture and infestation by insects. Paper cartons, if properly made and sealed, are insect proof, but none has yet been found to be entirely moisture proof. Freshly processed fruits packed in cartons lose weight steadily until the moisture content of the fruit reaches an equilibrium with the humidity of the surrounding air. Tin cans, especially if vacuumized and hermetically sealed, have been found to preserve the dried products in the best condition. Even when contaminated with insects and mold before packing, vacuum packing prevented spoiling and changes in moisture content. Enameled cans are necessary to prevent corrosion by acid products, especially in the case of sulfured fruits.

REPORT OF THE DIRECTOR OF THE AGRICULTURAL EXPERIMENT STATION

By C. M. Haring

The extent of the work of this station will be evident from an inspection of the paragraphs on pages 49–263 of this report in which the results of investigations during the year are summarized.

The following table gives the number of Experiment Station projects classified by divisions:

Number of Projects Classified by Divisions

Division	New Projects	Data Reported*	No Report*	Closed or Discontinued	Total Under Way July 1, 1923*
Agricultural Engineering	0	3	2	1	4
Agronomy	0	6	11	0	17
Animal Husbandry	2	6	7	0	13
Botany (Davis branch)	1	0	1	0	1
Chemistry (Davis branch)	1	0	1	0	1
Citriculture	2	25	14	0	39
Dairy Industry	5	4	3	0	7
Entomology	1	10	7	5	12
Farm Management	0	2	0	2	0
Forestry	3	11	2	0	13
Genetics	1	3	3	0	6
Irrigation Investigations	3	9	1	0	10
Landscape Gardening	0	0	2	0	2
Nutrition	1	1	2	0	3
Plant Nutrition	0	10	0	2	8
Plant Pathology	1	6	4	0	10
Pomology	4	26	14	2	38
Poultry Husbandry	0	1	0	0	1
Rural Institutions	2	1	3	0	4
Soil Technology	3	11	10	3	18
Truck Crops	6	0	9	0	9
Farm Division (Davis branch)	1	0	1	0	1
Veterinary Science	1	10	6	0	16
Viticulture and Fruit Products	3	19	27	0	46
	41	164	130	15	279

*Includes both new and old projects.

Certain of these projects are carried on jointly by two or more divisions, in which case credit has been given each division coöperating. Deducting for this duplication gives a total of 38 new projects, 153 projects upon which data have been reported, and 118 projects upon which no reports have been received during the past year. Deducting for both duplication and projects closed or discontinued, gives a total of 256 projects under way in the various divisions.

New Projects Organized During the Fiscal Year 1922-23.—New projects have been organized during the fiscal year in eighteen of the twenty-four divisions engaged in Experiment Station activities. Many of these projects are a result of the expansion of certain divisions through the addition of new members to the staff, for example, the projects on truck crops and related subjects are a result of the expansion of the work in Olericulture through the appointment of H. A. Jones of the University of Maryland as Associate Professor of Olericulture and head of the new Division of Truck Crops and J. T. Rosa of the University of Missouri as Assistant Professor of Olericulture. The establishment of the Division of Botany and Chemistry at the Branch of the College of Agriculture at Davis as a part of the provision for freshman and sophomore instruction has contributed to the work of the Experiment Station, particularly in truck crops, W. W. Robbins, Associate Professor of Botany, and C. S. Bisson, Professor of Chemistry, collaborating with Professors Jones and Rosa in several projects.

The addition to the staff of W. M. Regan of the New Jersey Agricultural Experiment Station as Associate Professor of Animal Husbandry, C. S. Mudge as Assistant Professor of Dairy Industry, and C. E. Tegner as Assistant in Dairy Industry, has strengthened the dairy investigations. Project No. 716, "Breeding Experiments with Dairy Cattle," is a continuation of an investigation inaugurated at the New Jersey station several years ago by Professor Regan, the experimental herd involved in the study having been purchased from the New Jersey station.

Range improvement studies are in progress under the supervision of A. W. Sampson, Associate Professor of Forestry, and certain projects in marketing and rural economics under the supervision of H. E. Erdman, Associate Professor of Rural Institutions, both of these men having joined the staff at Berkeley during the year.

Among other investigations initiated during the year are projects on plant breeding, weed control, insect pests and diseases of fruit trees and truck crops, vitamine content of foods, plant physiology, and viticulture. Project No. 729, "Miscellaneous Investigations Regarding Beneficial Insects," covers the work which was transferred from the State Department of Agriculture to the University by recent legislative action. (See page 41 of the Report of the Dean.)

Following is a list of the new projects organized during the fiscal year, 1922–23.

NEW PROJECTS ORGANIZED DURING THE FISCAL YEAR, 1922–23

No. 695. A study of the relation of closer settlement within irrigation projects to the feasibility and financial success of such projects. (Berkeley and various counties). A study of the factors which determine income and solvency of irrigation schemes and of California conditions in relation to these factors. By G. C. Kreutzer, C. F. Shaw, Elwood Mead, and David Weeks.

No. 696. The study and control of truck crop insects in California particularly the garden centipede, *Scutigerella immaculata* (Newport). (Delta Region in San Joaquin and Sacramento counties, Alameda County and Berkeley.) The life history and habits of such insects as the asparagus beetle and pea aphis in addition to the garden centipede will be studied in order to arrive at more definite means of control. By F. H. Wymore.

No. 697. Use of irrigation water on the University Farm, including observations on the fluctuation of the underground water table. (Davis.) This project is outlined as a means of permanently recording all data obtained in connection with the use of water on the University Farm, Davis. By means of the data will be determined the advisability of continuing to irrigate from certain wells, the water of which is saline in character. The study also looks to the preservation of the agricultural use of the land. By S. H. Beckett.

No. 698. The pruning of resistant mother vines. (Davis.) The continuous spread of phylloxera with the increased demand for cuttings of resistant stocks has made advisable this study which has for its purpose the discovery of methods for increasing the proportion of wood suitable for cuttings. By L. O. Bonnet.

No. 699. Control of wild morning glory (*Convolvulus Linnaeus*). (Davis.) This is one of the most serious weed pests of California and is spreading to all intensively farmed areas. A thorough test will be made of all the methods commonly used in controlling this weed, such as the use of smother or shade crops, the use of chemicals, and cultivation, in order to secure exact knowledge of their effectiveness. By Thos. Tavernetti.

No. 700. Various types of roughage for fattening lambs. (Davis.) To determine the feeding value of various types of roughages, such as whole alfalfa, chopped alfalfa hay, chopped barley straw, and bean straw, by means of feeding tests with grade feeder lambs. By R. F. Miller.

No. 701. Miscellaneous experiments with dairy equipment. (Davis.) Includes an investigation to determine the relative efficiency of the spray and flood methods of cooling milk in uninsulated tanks; also tests of efficiency of insulated and uninsulated concrete milk cooling tanks. By A. W. Farrall.

No. 702. Use of vacuum in the manufacture of butter. (Davis.) Cream for butter making usually deteriorates somewhat before it reaches the churn. Effort is being made to devise means of overcoming the effect of fermentative changes in cream before churning. By G. D. Turnbow and L. A. Raffetto.

No. 703. Investigations on the breeding of Nematode resistant plants. (Berkeley, Riverside, and elsewhere.) The primary purpose of this project is the conducting of fundamental investigations which will facilitate the future breeding of nematode resistant crop plants, attention being given at the same time to the development from the outset of such resistant varieties. By members of the Division of Genetics.

No. 704. A study of fruit tree diseases in Placer County. Various forms of winter injury and so-called "sour-sap" are being studied and methods of control tested. By J. P. Martin.

No. 705. Miscellaneous investigations in dairy bacteriology. (Davis.) A study of the salts in milk and the relation of these salts to the quality of milk. It is possible that bacteria may influence the salts normally found in milk. By C. S. Mudge.

No. 706. Sweet potato storage methods and storage practices. (Davis.) To determine the relation of different factors of the storage conditions to keeping quality and shrinkage of stored potatoes. Sweet potato storage in California offers distinct problems, owing to the high relative humidity of the atmosphere during the winter and the fact that the stored product is grown under irrigation, a circumstance supposed to lower the quality for shipping and storage. By J. T. Rosa.

No. 707. A study of factors affecting fruiting habits in the cantaloupe. (Davis.) A study to determine how, if possible, conditions within the melon may be altered so that a higher ratio of pistillate to staminate blossoms may be produced, also that the pistillate blossoms may be produced earlier in the plant's life. Conditions favorable for fruit setting will also be studied. By J. T. Rosa.

No. 708. Dormancy studies on tuber, bulb, and root crops. (Davis.) This project includes dormancy studies on the potato and the onion with the aim of determining whether the dormant periods of these crops may be modified. Potato dormancy as a factor in production is the most serious problem facing the potato growers of southern California. By H. A. Jones and J. T. Rosa.

No. 709. Asparagus investigations. (Davis.) A. Asparagus crown selection studies at time of planting. By H. A. Jones. B. Root crown development in common asparagus (*Asparagus officinalis*). By W. W. Robbins and H. A. Borthwick. C. Sexuality in common asparagus (*Asparagus officinalis*). By W. W. Robbins and H. A. Borthwick. California has almost a monopoly of the asparagus industry at present. Conditions are fairly healthy and prosperous now, but much investigational work needs to be done upon the asparagus crop to insure continued prosperity and to provide for greater expansion.

No. 710. Influence of the number of fruit-buds on the quality and quantity of the vine crop and on the prevalence of "waterberries" and "Black Measles." (Various counties.) There is reason to suspect that both "waterberries" and black measles" are the result of allowing the vines to bear excessive crops. The effect of long as contrasted with short pruning is being tested on Muscat, Tokay and Sultanina to determine the relation of amounts of fruiting wood to these troubles. By F. T. Bioletti.

No. 711. Study of the soil conditions in Placer County as possible cause of injury to orchards. This project is part of the study of the possible causes of the severe loss of trees in the orchards of this section. The soil conditions in the orchards of the region will be investigated and the possible relation of soils to injury worked out. By R. E. Storie and C. F. Shaw.

No. 712. Leaching of drained alkali lands in Imperial Valley. The alkali of the Imperial Valley is largely chlorid and sulfate of sodium and consequently is of the character most easily removed after the water table is lowered. This study aims to work out the best procedure for removing the alkali in order that the owners may be spared needless expense. By W. W. Weir and E. L. Garthwaite.

No. 713. Planting and maintenance of an instruction vineyard at Davis. To afford material for the instruction of students in the best accepted practices of grape growing, including those adapted to the development of young vines and to the management of mature bearing vines of the principal commercial varieties. By F. T. Bioletti and L. O. Bonnet.

No. 714. The marketing of California sweet potatoes, Irish potatoes, cantaloupes and watermelons. (Berkeley and various counties.) The methods by which these crops are now being marketed will be studied and the functions performed by each of the classes of agencies now taking part in the movement of these crops determined. Among other points to be investigated are the proportion of the consumer's dollar taken by each agency, the methods of price determination, and present and possible markets for the products. By H. E. Erdman and Elwood Mead.

No. 715. The cause of fishy flavor in dairy products. (Davis.) Off flavors in butter are responsible for considerable financial losses in the California markets. A study is being made of the causes of these bad flavors, particularly of the so-called "fishy" flavor. Special culture methods will be employed to determine whether or not these are due to bacteria. By C. L. Roadhouse and C. S. Mudge.

No. 716. Breeding experiments with dairy cattle. (Davis.) To determine the method of breeding that will best fix and insure the transmission of high production in dairy cattle. Certain phases of this experiment were carried on at the New Jersey Experiment Station for four years. The animals involved and the entire data collected have been transferred to the University of California, the experiment to be completed here, due credit to be given in subsequent publications to the New Jersey Experiment Station for data collected prior to the transfer. By W. M. Regan.

No. 717. The manufacture of cheese from goat's milk. (Davis.) There is an increased demand for manufactured dairy products made from goat's milk. It is expected that several varieties of cheese made from goat's milk will eventually be developed. By C. A. Phillips and C. E. Tegner.

No. 718. The control of certain soil-borne diseases of Irish potatoes. (Davis and various counties.) Attempt will be made to develop varieties resistant to the Fusarium "wilt" disease. The relation of certain fertilizers to the control of this disease and also to the control of the common scab disease will be studied. By J. T. Rosa.

No. 719. Influence of climatic factors and methods of handling upon carbohydrate and protein metabolism in the garden pea. (Davis.) To secure exact information on the factors affecting yield and shipping quality in connection with table quality. This information is necessary for the successful marketing of California garden peas in the eastern states. By C. S. Bisson and H. A. Jones.

No. 720. Revegetation and maintenance of California foothill range lands. (Various counties.) The chief object of this investigation is to develop, with the life history requirments of the more important pasture plants as a basis, a plan of revegetation and maintenance of the forage cover which may be widely applied by stockmen. By A. W. Sampson.

No. 721. The factors affecting winter injury to figs. (Planada, California.) Among the points to be investigated are the relation of irrigation practice to frost injury and of pruning to frost resistance; the comparative resistance of varieties to cold injury; and means of protecting trees from frost injury. By J. C. Johnston.

No. 722. Studies of trees suitable for planting without irrigation in the Berkeley Hills. (Berkeley.) Tests will be made of promising species to determine the practicability of establishing plantations under the existing climatic conditions at a comparatively reasonable expense. By W. Metcalf.

No. 723. The organic nutrition of fruit trees. (Berkeley.) From the data to be obtained, it is hoped to derive an understanding of the quantitative production of food by the tree, its distribution and use in growth and fruit production, and the main factors which modify these. By J. P. Bennett.

No. 724. General investigations in plant physiology in relation to horticulture. (Various counties.) A study of the rest period of deciduous fruit trees and of the nitrogen metabolism of the potato tuber during its rest period. By W. L. Howard and staff.

No. 725. A study of certain foods, and food products with respect to their content of vitamin C. (Berkeley.) Designed to meet the demands for information concerning the nutritional worth of certain typical California foods and food products. By M. E. Jaffa and H. Goss.

No. 726. Thinning of deciduous fruits. (Davis.) Thinning is one of the methods by which the orchardist may regulate the size and quality of his crop, yet little definite information exists either from the standpoint of plant nutrition or of actual field practice. This project is designed to furnish this information. By W. P. Tufts.

No. 727. A study of the physiological factors influencing the production and development of root hairs with particular reference to the genus Citrus. (Berkeley.) To learn the underlying causes which result in the production or absence of root hairs on the roots of citrus plants, information which may be of value in indicating the selection of citrus root-stocks best adapted for specific soil conditions. By H. J. Webber and staff.

No. 728. Measurement of irrigation water. (Davis and various counties). A field laboratory study of standard devices, together with tests of certain hydraulic formulas. By H. A. Wadsworth.

No. 729. Miscellaneous investigations regarding beneficial insects. (Riverside and Whittier). This project covers the experimental work on beneficial insects which was transferred from the State Department of Agriculture to the University by legislative action. The work the coming year will concern especially investigations in the control of citrus scale pests by means of parasites. By H. S. Smith, H. M. Armitage, A. J. Basinger, H. Compere, and E. W. Rust.

No. 341–C. Study of soil factors relating to the growth of alfalfa on certain areas at Davis. Certain irregular shaped areas in a field of alfalfa under observation by the Division of Irrigation Practice showed marked variation in growth. The causes for this variation being obscure, it is proposed to make such investigations of the soil, its texture, physical condition, moisture content, moisture penetration, etc., as may lead to a solution of the problem. By R. E. Storie and A. Smith.

No. 633–A. Irrigation studies with the Delhi Muir Peach Orchard. A study of the response of peach trees to different irrigation treatments under San Joaquin Valley conditions. By F. J. Veihmeyer and A. H. Hendrickson.

No. 656–C. Abortion infection experiments with young calves. (Berkeley.) A study of the location of *Bacterium abortum* organism in the bodies of calves drinking artificially infected milk, also the effect of the ingestion or withdrawal of colostrum as a factor. By G. H. Hart and C. M. Carpenter.

No. 670–A. Methods of thinning stands of redwood second growth. (Various counties). Various methods of thinning will be tested in order to determine those most conducive to maximum rate of growth and value of product. By W. Metcalf.

PROJECTS ON WHICH PROGRESS REPORTS HAVE BEEN FILED DURING THE FISCAL YEAR, 1922–23

Agricultural Engineering

No. 400. Power required for plowing. (Davis.) The study of the draft and strength of disk harrows is being continued as a part of the program of standardization, the aim of which is to eliminate either the full blade or the cutaway disk harrow. By A. H. Hoffman.

No. 606. Miniature rod row grain thresher and separator. (Davis.) The object of this investigation is to design and build a machine which will remove satisfactorily from the straw grains and grasses grown in rod rows in the plant breeding work. By A. H. Hoffman.

No. 607. Tractor hitches. (Davis.) To find hitches which are adapted for certain purposes, such as the overcoming of sidedraft; also to learn the proper application of tractors to farm implements. By A. H. Hoffman.

No. 621. Miscellaneous tests of tractors and farm machinery. (Davis.) Includes a number of sub-projects, such as tests of the efficiency of air cleaners, and the tendency of tractors to rise in front. By A. H. Hoffman.

Agronomy

No. 174. Crop rotation experiments. (Davis and Kearney.) This experiment begun in 1913, consists of 52 one-twentieth acre plots and has for its object the determination of the effect of various crop rotations upon soil fertility and crop yields. By J. P. Conrad and B. A. Madson.

No. 176. Variety trials and cultural experiments with small grains. (Davis.) To devise more efficient methods of production and to improve the yield and quality of cereals in California. In 1922 the work of this experiment was greatly enlarged through a coöperative agreement with the Office of Cereal Investigations, U. S. D. A., whereby the Federal cereal nurseries formerly maintained at Chico were moved to Davis and combined with this project. By V. H. Florell (U. S. D. A.).

No. 283. Experiments with Non saccharine sorghums, saccharine sorghums, and broom corn. (Imperial.) Higher yielding varieties and more uniform growth, facilitating the harvesting by machinery, are the leading objects of this project. By L. G. Goar.

No. 591. Seed and plant accessions. (Davis). This project has for its object the trying out of all new and introduced crops and the perfecting of those of value under California conditions. The information accumulated serves a large purpose in answering correspondence with farmers and others. By. J. P. Conrad, J. F. Duggar, and G. W. Hendry.

No. 635. Agronomic studies of rusts on cereals and grasses. (Berkeley and Davis.) (Ten sub-projects.) Carried out mainly along two lines: the devising of remedial treatments for soil, seed, and plants, and the breeding of resistant varieties. By W. W. Mackie, Ruth Allen, and P. B. Kennedy, in coöperation with the Office of Cereal Investigations, U. S. D. A.

No. 636. Agronomic studies of smuts on cereals. (Berkeley and Davis.) (Four sub-projects.) Carried out under a plan similar to that of Project No. 635. By W. W. Mackie, in coöperation with the Office of Cereal Investigations, U. S. D. A.

Animal Husbandry

No. 625. Range cattle experiment. (Davis, Shingle Springs, and the Eldorado National Forest.) C. E. Howell and O. L. Lovejoy.

No. 661. A study of rice and rice by-products in swine metabolism. (Davis.) To determine the value of rough rice, rice polish, and rice bran as swine feeds, and the value of rice and rice by-products when supplemented with tankage or other nitrogenous concentrates, for the same purpose. By E. H. Hughes.

No. 690. Hydrolyzed tannery waste versus tankage as protein feeds for growing swine. (Davis.) Large amounts of tannery waste are now available as a source of animal protein. The aim of this investigation is to determine its value as a protein supplement to the ration of swine. By F. W. Woll, E. H. Hughes, and B. H. Thomas.

No. 691. An investigation of the Schweizer electrical method of preserving green forage. (Davis.) To investigate the merits of this method of preserving forage with a view to its study on a large scale under ordinary ranch conditions if the results of the trials are promising. By F. W. Woll and R. F. Miller in coöperation with A. H. Hoffman of the Division of Agricultural Engineering.

No. 700. Various types of roughage for fattening lambs. (Davis.) A greater interest is being manifested each year in the fattening of lambs for market. This investigation has for its object the determination of the value of the various roughages available to California farmers as feed for fattening lambs. By R. F. Miller.

No. 691. To determine whether the hog stores fat soluble vitamine A in its body fat. (Davis and Berkeley.) The aim of this investigation is to determine the relation of the diet to the existence or non-existence of this food element in hog fat. By E. H. Hughes in coöperation with H. M. Evans and Katherine Scott Bishop of the Department of Anatomy and M. E. Jaffa of the Division of Nutrition.

CITRICULTURE

No. 191. A study of the fertilizer requirements of citrus fruits. (Riverside.) To determine the elements actually demanded by citrus fruits and the proportion and source of these that give the best results in practice. By R. S. Vaile.

No. 197. A study of the comparative infectiousness of the crown gall organism (*Bacterium tumefaciens*), with special reference to finding resistant forms of Prunus suitable as a root-stock for the various stone fruits. (Riverside.) By C. O. Smith.

No. 261. The breeding and improvement of citrus fruits. (Riverside.) Mainly the production and study of citrus hybrids; to produce new and superior varieties, and also to obtain evidence on the inheritance of important characters and on the nature and basis of bud variation and of variation in F_1 hybrids. By H. B. Frost.

No. 262. The principles of heredity in certain plants. (Riverside.) A study in genetics designed to augment existing knowledge of the nature and behavior of genes (hereditary factors). By H. B. Frost.

No. 263. The origin, nature and inheritance of apparent mutations in certain plants. (Riverside). A genetic and cytological study of hereditary variations which apparently are not due to segregation and recombination of genes. By H. B. Frost.

No. 303. Studies of the behavior of dates in the Imperial Valley. (Meloland.) To determine the possibility of rearing seedling dates and of developing meritorious varieties through cross-breeding. By H. J. Webber.

No. 335. Observations and studies on internal decline of lemons. (Riverside.) A project financed to March 1, 1923, by the Lemon Men's Club. This project has been enlarged to include a study of Alternaria rot of lemons, owing to the discovery that the "later stages" of the internal decline of lemons is in reality a different disease caused by a fungus, whereas internal decline is of a purely physiological nature. By E. T. Bartholomew.

No. 336. A study of the chemical and physical effects of nitrate of soda on citrus soils. (Riverside.) To determine the chemistry of the action of nitrate of soda on soils, with special reference to mottle leaf in citrus. By W. P. Kelley, E. E. Thomas, and S. M. Brown.

No. 351. Experiments in the management of old groves. (Riverside.) Many groves in California, especially old groves, become so seriously affected with mottle leaf as to be unprofitable. This study aims to determine the most practical methods that can be used to arrest the decline in such groves and bring them back to a normal, healthy and productive condition. By R. S. Vaile.

No. 360. Study of cost accounting for citrus orchards with a view to determining as far as possible the actual value of cultural practices. (Riverside.) To determine the inter-relations between various cultural practices and to combine, if possible, the various systems used into a more complete and more economical plan. By R. S. Vaile.

No. 368. Walnut breeding investigations. (Riverside). To enlarge the existing knowledge of the laws of inheritance in the walnut and to improve the technic of walnut hybridization, to the end that better varieties may be produced. By L. D. Batchelor and D. C. Wylie.

No. 387. A physiological study of the effect of pruning upon the growth and productiveness of citrus trees and other horticultural plants grown under irrigation in arid regions in southern California. (Riverside.) This project was begun in 1915 to work out definite knowledge of the effects of pruning certain sub-tropical fruits and to determine the best methods to follow. By H. S. Reed, F. F. Halma, and R. McBride.

No. 455. Sunburning and winter-killing of walnut trees. (Riverside). To obtain information concerning the factors which influence the occurrence of these troubles, with a view to selecting hardier varieties. By H. S. Reed and L. D. Batchelor.

No. 555. Field trials of fertilizers and green manure crops with walnuts. (Riverside.) The main point investigated is the effect on crop production of the application of those plant food elements most generally found as limiting factors in crop production: nitrogen, phosphoric acid and potash together with humus. By L. D. Batchelor.

No. 576. The cold storage of certain semi-tropical fruits. (Berkeley.) This study is devoted especially to determining the keeping qualities in cold storage of the avocado, as an aid in the marketing of this fruit. By F. R. Hodgson.

No. 579. A study of apricot bacterial gummosis and its control. (Various counties.) Includes observations and studies of a disease of apricot trees apparently new to California at the time first observed in 1916, and which appears to be related to cherry gummosis of western Oregon. By J. T. Barrett.

No. 585. Bean breeding for interior dry-land conditions in California. (Riverside.) To find or produce valuable types of beans for the hot, dry interior valleys of California. By H. B. Frost.

No 594. Planning, planting and early care of a citrus orchard for future experimental work. (Riverside). This orchard has been laid out in order that certain field trials in soil management, fertilization and irrigation as affecting citrus trees may be conducted later. No differential treatments are to be applied for a period of from three to eight years. By L. D. Batchelor, R. McBride, and C. Wilson.

No. 599. Citrus blast. (Riverside and various counties.) To investigate the causal conditions influencing the severity of this disease and to develop methods of controlling it and preventing its spread. By H. S. Fawcett, A. F. Camp, and W. T. Horne.

No. 611. Souring and splitting of figs. (Berkeley and various counties.) To determine the cause of these troubles and their possible relation to each other and to develop remedial measures. By J. C. Johnston.

No. 631B. Walnut curing investigations. (Riverside, Berkeley and various counties.) To investigate the artificial drying of walnuts, determining the conditions most favorable for the work. By L. D. Batchelor.

No. 632. A study of the chemical, physical, and physiological effect of salts on soils and crops, and of methods of reclaiming alkali lands. Four sub-projects in coöperation with the Divisions of Soil Technology and Plant Nutrition. (Riverside, Kearney, and various counties.) By W. P. Kelley, E. E. Thomas, S. M. Brown, A. R. C. Haas, and H. S. Reed.

No. 634. The importance of selection in the improvement of citrus stocks. (Riverside.) This investigation includes a careful test of different sized budded nursery trees to determine their comparative growth and value for orchard planting; also a study of seedlings of certain citrus types used in citrus propagation, with a view to determining the causes of variation in orchard trees. By R. McBride, and J. T. Barrett.

No. 721. The factors affecting winter injury to figs. (Planada, California.) Among the points to be investigated are the relation of irrigation practice to frost injury and of pruning to frost resistance; the comparative resistance of varieties to cold injury; and means of protecting trees from frost injury. By J. C. Johnston.

No. 727. A study of the physiological factors influencing the production and development of root hairs, with particular reference to the genus Citrus. (Berkeley.) To learn the underlying causes which result in the production or absence of root hairs on the roots of citrus plants, information which may be of value in indicating the selection of citrus root-stocks best adapted for specific soil conditions. By H. J. Webber and R. E. Girton.

Dairy Industry

No. 641. Miscellaneous experiments and reports on the manufacture of dairy products. (Davis.) A comparison of the Babcock and Roeese-Gottlieb (Majonnier) tests for butterfat in milk which has been reported by three separate investigators, none of whom has agreed on the extent of the variation between the two methods. By C. A. Phillips.

No. 701. Miscellaneous experiments with dairy equipment. (Davis.) Includes an investigation to determine the relative efficiency of the spray and flood methods of cooling milk in uninsulated tanks; also tests of efficiency of insulated and uninsulated concrete milk cooling tanks. By A. W. Farrall.

No. 702. Use of vacuum in the manufacture of butter. (Davis.) Cream for butter making usually deteriorates somewhat before it reaches the churn. Effort is being made to devise means of overcoming the effect of fermentative changes in cream before it is churned. By G. D. Turnbow and L. A. Raffetto.

No. 705. Miscellaneous investigations in dairy bacteriology. (Davis.) A study of the salts in milk and the relation of these salts to the quality of milk. By C. S. Mudge.

No. 715. The cause of fishy flavor in dairy products. (Davis.) Off flavors in butter are responsible for considerable financial losses in the California markets. A study has been made of the causes of these bad flavors, particularly of the so-called "fishy" flavor. Special culture methods have been employed to determine whether or not these are due to bacteria. By C. S. Mudge.

Entomology and Parasitology

No. 150. Malaria-mosquito investigations. (Berkeley and various counties.) To devise means of combating malaria in those sections of the state where this disease is a serious handicap to agricultural development. By W. B. Herms.

No. 601. Investigations and demonstrations in the control of insects attacking deciduous fruit trees in California. (Various counties.) The common deciduous fruit insects are studied with regard to modern methods of dusting and spraying. By E. O. Essig.

No. 644. A study of the control of the peach twig borer (*Anarsia lineatella*, Zellar). (Various counties.) The peach twig borer is one of the three or four most destructive insects affecting stone fruits in California. The aim of the investigation is to experimentally test the effectiveness for almonds, apricots and plums of the control measures used for peaches; also to make further observations concerning the life history of the insect. By W. P. Duruz.

No. 657. Entomology and parasitology of curly leaf of sugar beets. (Berkeley.) Further years of continuous work of a technical nature will be required to discover the causative disease factor, which discovery may also throw light upon other insect borne plant diseases now obscure. By H. H. Severin.

No. 665. Miscellaneous studies in forest entomology, insect taxonomy, and insect biology. (Berkeley and various counties.) These studies are necessary to furnish a complete and up-to-date body of knowledge for use in connection with the varied experiment station problems of the Division of Entomology and Parasitology. By E. C. Van Dyke.

No. 681. Studies in poultry parasitology. (Berkeley and Petaluma.) The life histories of some of the internal parasites that are causing the most serious losses to the poultry industry have never been carefully worked out. This project is designed to furnish definite information affording adequate basis for treatment. By S. B. Freeborn.

No. 682. Codling moth control and arsenical residue investigations. (Santa Clara County.) Because of peculiar climatic conditions and the varieties involved, the apple growers of the Alviso section of Santa Clara County have been unable to satisfactorily control codling moth. The aim of the investigation is to devise measures which will at once control the insect and remove the possibility of arsenical residue. Further studies on the life history of the codling moth will also be made. By E. R. deOng and J. F. Lamiman.

No. 683. Para-dichlorobenzene treatment for the control of the peach borer (*Oegeria opalescans* H. Edw.), the pear root aphis (*Eriosoma languinosa* Hartwig), the wooly apple aphis (*Eriosoma lanigera* Hausm.), and other root infesting insects. (Santa Clara County.) To obtain more definite information on the effectiveness of the para-dichlorobenzene treatment for the control of these insects under California conditions. By E. O. Essig.

No. 684. The volatility and toxicity of nicotine as an insecticide and parasiticide. (Berkeley.) The object of this work is to obtain a stabilized and standard nicotine dosage that will be effective as an anthelmintic without being injurious to the animal. By E. R. de Ong.

No. 696. The study and control of truck crop insects in California, particularly the garden centipede, *Scutigerella immaculata* (Newport). (Berkeley and various counties.) To work out definite and systematic control measures for certain insects which do great damage to truck crops each year and which have increased with the expansion of such crops in the state. By F. H. Wymore.

Farm Management

No. 617. Leasing of California farm lands. (Berkeley.) To provide a body of data showing the status of leasing, its possibilities for gaining a start in farming, its limitations, its possible abuse and any corrective needs, as an aid to constructive measures for placing California agriculture on a basis as nearly sound and permanent as possible. By R. L. Adams.

No. 672. Investigations into the cost of producing whole milk and butterfat on California dairies. (Various counties.) Includes the determination of the cost of producing milk in various sections of the state, the factors involved in such costs, the analysis of individual dairies to determine their relative profitableness, and the compilation of data for the use of the associations of dairymen and individual farmers. By R. L. Adams.

Forestry

No. 430. Factors affecting the cost of log making and skidding. (Various counties.) A detailed investigation of cost factors necessary to further progress in efficiency in logging. By D. Bruce.

No. 446. The artificial reproduction of redwood (*Sequoia sempervirens*). (Berkeley.) To determine the possibility of propagating the redwood by means of seed, which, if successful, will aid in the reforestation of cutover lands. By W. Metcalf.

No. 447. A study of the growth and yield of various species of Eucalyptus on different sites in California. (Various counties.) To determine the possibilities of the different species of eucalyptus for planting in California, their yield on different sites and management to secure best results. By W. Metcalf.

No. 475. Preparation of volume tables for principal California species. (Various counties.) In modern forestry all timber estimates depend upon volume tables, the accuracy of which limits the accuracy of the forest inventory. This project is designed to make more accurate the existing volume tables for California species. By D. Bruce.

No. 496. Studies in adaptability and rate of growth of trees at the Chico Forestry Station. (Chico.) Measurements of diameter and height will be made periodically of the various species, from which data the volume growth per tree and acre will be figured as an indication of what may be expected of these species under similar conditions through the state. By W. Metcalf.

No. 651. A survey of the wastes resulting from the logging and milling of California redwood and associated species. (Various counties.) This project is designed to throw light on the problem of reducing wastes in logging and milling, the increased cost of manufacturing and the necessity for conserving timber supplies having made this important. By E. Fritz.

No. 652. Relative durability of various pines, and of redwood cut from old and second growth. (Berkeley.) To secure information necessary to the lumber industry of the state, a question having arisen as to the relative value of certain varieties of pine when used in window sash, and of lumber and posts cut from second growth redwood. By E. Fritz.

No. 670. Experiments in artificial reforestation of redwood cut-over lands. (Various counties.) To determine the best species of trees to grow in association with redwood (1) to insure a fully stocked stand on redwood cut-over lands in order to aid in the proper development of redwood coppice; and (2) to produce if possible a commercially valuable lumber not now grown or manufactured in California. By W. Metcalf.

No. 688. Properties and uses of second growth redwood. (Various counties.) To determine the qualities, properties and utility of second-growth redwood, and thus the value of work in reforestation. By E. Fritz.

No. 720. Revegetation and maintenance of California foothill range lands. (Various counties.) The chief object of the investigation is to develop, with the life history requirements of the more important pasture plants as a basis, a plan of revegetation and maintenance of the forage cover which may be widely applied by stockmen. By A. W. Sampson.

No. 722. Studies of trees suitable for planting without irrigation in the Berkeley Hills. (Berkeley.) Tests will be made of promising species to determine the practicability of establishing plantations under the existing climatic conditions at a comparatively reasonable expense. By W. Metcalf.

Genetics

No. 190. Cross-breeding peaches with reference to (1) improved fruits, (2) improved rootstocks, and (3) study of inheritance in *Amygdalus*. (Riverside and Davis.) A study to improve the peach by cross-breeding. By E. B. Babcock.

No. 693B. Breeding disease resistant tomatoes with special reference to the Western Blight or Summer Blight. (Riverside.) To obtain improved varieties for commercial planting. Involves testing the behavior of selections together with numerous commercial varieties under disease producing conditions; also hybridization with a view to combining resistance to disease (especially western yellow blight and wilt) with productiveness and high quality for canning or shipping. By J. W. Lesley.

No. 703. Investigations on the breeding of nematode resistant plants. (Berkeley and various counties.) A search for immune varieties of cantaloupes, tomatoes, cowpeas, and tree fruits from rooted cuttings. By E. B. Babcock and W. S. Malloch.

Irrigation Investigations

No. 440. Irrigation of vineyards. (Davis.) (In coöperation with Division of Viticulture and Fruit Products.) By S. H. Beckett.

No. 442. Irrigation investigations with field crops. (Davis.) A general project used mainly in connection with instruction in irrigation practice, but also including a continuation of studies of the time and depth of alfalfa irrigation. By S. H. Beckett.

No. 633. Moisture requirements of deciduous orchards. (Coöperation with Division of Pomology.) A study of the behavior of fruit trees under different irrigation treatments; also of the losses of moisture from irrigated soils and the movement and distribution of water applied to soils in irrigation. By F. J. Veihmeyer, and A. H. Hendrickson. A. Irrigation studies with a Delhi Muir peach orchard. A study of the relation of soil moisture conditions to the growth of trees and vines and the development of fruit on sandy soils. By A. H. Hendrickson.

No. 646. Irrigation of alfalfa. (Delhi.) (Coöperation with Division of Engineering and Irrigation, State Department of Public Works, and State Land Settlement Board.) A repetition of experiments conducted over a five-year period at Davis to determine the most economical duty of water for alfalfa and the best time and depths of single irrigations. By M. R. Huberty and Frank Davis.

No. 654. Community irrigation movements in California. (Davis and various counties.) A study of the economics of irrigation organization, including mutual water companies, irrigation, water storage, waterworks, county irrigation, and reclamation districts, also districts operating under special laws, and public utility irrigation companies. By Frank Adams.

No. 660A. Rice investigations in Sacramento Valley. Includes water grass control through manipulation of irrigation water, time and method of seeding, rotation of other crops with rice, and irrigation methods. By Frank Adams and C. F. Dunshee in connection with the Rice Committee of the Agricultural Experiment Station.

No. 694. Duty of water for field crops in Sacramento Valley. (Davis.) An investigation of variation in yields resulting from variation in time and depth of application of irrigation water. By S. H. Beckett.

No. 697. Use of irrigation water on the University Farm, including observations on the fluctuation of the underground water table. By S. H. Beckett.

No. 728. Measurement of irrigation water. (Davis.) A field laboratory study of standard devices, together with tests of certain hydraulic formulas. By H. A. Wadsworth.

Nutrition

No. 725. A study of certain California foods, and food products with respect to their content of Vitamin C. (Berkeley.) Designed to meet the demands for information concerning the nutritional worth of certain typical California foods and food products. By M. E. Jaffa and H. Goss.

Plant Nutrition

No. 204. Modification of soil flora through climatic influences. (Various counties.) Closed. By. A. R. Davis.

No. 330. A study of the underlying factors influencing soil fertility as evidenced by the chemical composition of the soil solution. (Berkeley.) By J. C. Martin and J. S. Burd.

No. 488. The cumulative effect of cropping. (Berkeley.) Designed to secure light on certain inter-relations between the plant nutrients and also on the productive life and power of recovery of soils. By J. C. Martin and J. S. Burd.

No. 490. Study of the relation of the concentration of nutrient solutions to the growth of barley in sand and water cultures and the relation of solution to absorption and forms of combinations of important elements. (Berkeley.) Important in connection with soil solution studies, bearing also on function of inorganic elements. Other plants than barley are included. By A. R. Davis and D. R. Hoagland.

No. 546. New studies in nitrogen fixation. (Berkeley.) A study of bacterial fixation of nitrogen, the magnitude of such fixation in nature and the energy relations concerned therewith, especially in relation to thermochemical and electrochemical methods for nitrogen fixation. Closed. By A. R. Davis.

No. 559. Studies on the nutrition of plants as affected by nitrogen and sulfur and by salts, the results of which will throw much light on requirements of plants and the relation of the soil solution to quality of crops, e.g., protein content of wheat. (Berkeley.) By W. F. Gericke.

No. 632C. Experiments on the relative tolerance of certain crops to alkalinity and high concentration of salts and a further study of methods of testing alkali soils, with special reference to the correlation between chemical tests and toxicity to plants. (Berkeley.) By A. R. Davis and D. R. Hoagland.

No. 632D. Testing water of wells in the Sacramento Valley to determine their fitness for irrigation. Completed. By P. L. Hibbard.

No. 660B. Rice investigations in the Sacramento Valley. Chemical studies of water and soils. By P. L. Hibbard.

No. 666. The carbohydrate metabolism of plants. (Berkeley.) This study involves slow and laborious experimentation, but the results are indispensable to certain phases of wood utilization and plant nutrition. By W. H. Dore.

No. 668. Public service work of the Division of Plant Nutrition consisting mostly of soil and water examinations. (Berkeley.) A large number of samples of soil and water are examined each month. By P. L. Hibbard.

Plant Pathology

No. 117B. Record of materials sent in. Consists in the records covering the public service rendered by the Division. By R. E. Smith, E. H. Smith, and W. T. Horne.

No. 599. Citrus blast. (Riverside and various counties.) Coöperation with Citriculture.) To investigate the casual conditions influencing the severity of this disease and to develop methods of controlling it and preventing its spread. By W. T. Horne, H. S. Fawcett, and A. F. Camp.

No. 673. Fig diseases. (Berkeley and San Joaquin Valley.) The study of the etiology and control of several diseases of the fruit of the fig has been continued. By R. E. Smith and E. H. Phillips.

No. 674. The control and use of nicodust and other dust materials for the control of plant pests and diseases. (Berkeley and various counties.) The cost of nicotine dusting has been much decreased and its efficiency increased by the development of a "self-mixing" dusting machine. By R. E. Smith.

No. 693A. Improvement of tomato varieties with particular reference to the disease called Western Blight or Summer Blight. (Various counties.) Promising varieties and strains are being tested for disease resistance and canning quality. By F. L. Yaw.

No. 704. A study of fruit tree diseases in Placer County. Various forms of winter injury and so-called "sour sap" have been studied and methods of control tested. By J. P. Martin.

Pomology

No. 158. The pollination of Domestica and Triflora plums under California conditions. (Mountain View.) A study of the self-fertility and self-sterility of the principal varieties of plums and prunes with a view to discover the best combinations for regular production. By A. H. Hendrickson.

No. 385. Planting distances for deciduous orchard trees. (Davis.) A comparison of the behavior and growth of the principal deciduous fruit trees and also the acre yields under Sacramento Valley conditions when planted at distances varying from 12 to 36 feet. By F. W. Allen.

No. 389. Apricot pruning. (Davis.) A study of the influence of early and late summer pruning, both heavy and light, as well as different degrees of severity of cutting during the dormant season upon the growth and yield of apricot trees. Some forty different varieties are under observation. By C. Lloyd Austin.

No. 402. Pecan culture in California. (Davis.) A study of the adaptability of present commercial varieties to the soil and climatic conditions of California, also a study of the possible further development of the pecan industry in this state. By W. P. Tufts.

No. 470. Pollination studies. (Berkeley, Davis and various counties.) A study of the pollination requirements of the various deciduous fruits, including a study of the factors causing sterility in such fruits as the almond and the cherry. By G. L. Philp.

No. 470A. Investigation on the fertility and sterility of deciduous fruits with special reference to the sweet cherry. (Davis.) By W. P. Duruz.

No. 470B. Pollination experiments with Yellow Newtown and Yellow Bellflower apples in the Pajaro Valley. Pollination experiments to determine the amount of self-sterility and inter-sterility among the different varieties of apples in the Sebastopol section. By E. L. Overholser and E. H. Rawl.

No. 471. Fruit bud formation and development. (Davis and various counties.) A careful study of fruit buds through every stage of their life history with a view to determining the factors influencing the fruitfulness of the various species. By W. P. Tufts and C. B. Wiggans.

No. 487. Pruning studies. (Davis and various counties.) A general study of the pruning of deciduous fruit trees, comparing special practices as they exist with the pruning practice generally accepted as standard. By C. Lloyd Austin.

No. 526. A survey of the deciduous fruit drying industry of the state. (Various counties.) A study of the dried fruit industry of California including localities, varieties, yields, methods, equipment, and costs of production. By A. W. Christie, L. C. Barnard, and E. H. Guthier.

No. 527. Effects of sulfuring on fruit tissues and its possible relation to the palatability of the dried product. (Berkeley.) A study of the oxidase system of apples to determine factors affecting darkening of the tissue. By E. L. Overholser and W. V. Cruess.

No. 530. An experimental study of equipment for drying and curing of deciduous fruits on a commercial scale. (Davis.) By A. W. Christie.

No. 532. A study of the comparative keeping qualities of different varieties of pears in cold storage. (Berkeley.) A study of the effect of high and low temperatures upon the keeping quality and ripening of pears. By E. L. Overholser.

No. 533. The keeping qualities of apples in cold storage as affected by the health and vigor of trees. (Berkeley.) Includes a study of factors influencing the development of internal browning of the Yellow Newtown apple. By E. L. Overholser, A. J. Winkler, and H. E. Jacob.

No. 534. A demonstration and study of the effect of degree of stage of ripeness of fruit at picking upon its behavior in cold storage. (Berkeley and Davis.) A study of the effect of maturity and region wherein grown upon the keeping quality of plums at different temperatures. By E. L. Overholser, E. H. Rawl, and R. J. Blatt.

No. 576. The cold storage of certain semi-tropical fruits. (Berkeley.) The behavior of certain varieties of persimmons and jujubes at 32° F., and the effect of CO_2 fumes upon the astringency of the Gosho Japanese persimmon. By E. L. Overholser and F. R. Hodgson.

No. 604. Storage of fruits at low temperatures for preserving, canning and soda fountain use. (Berkeley.) A study of the preservation of different fruits in the fresh condition by means of freezing temperatures; also the effect of freezing in sugar solution upon changes in chemical composition and quality. By E. L. Overholser, W. V. Cruess, and J. G. Brown.

No. 612. Rejuvenation of old fruit trees with special reference to prunes. (Mountain View.) A study of methods of management of value in causing old trees to produce profitable crops regularly, especially methods of pruning. By A. H. Hendrickson.

No. 613. Root-stock investigations. (Davis and various counties.) Certain difficulties of deciduous fruits in California are associated with the roots on which they grow. This study is an endeavor to find introduced forms or native species that are better adapted to California conditions. By W. L. Howard and A. H. Hendrickson.

No. 614. Pear blight control with special emphasis on horticultural methods. (Davis and various counties.) The control of pear blight at present seems to have been reduced to a horticultural problem. Attempts are being made to find varieties or at least root-stocks resistant to the disease. Very complete tests of disinfectants with and without treatment of the bark are being made. By W. L. Howard and L. H. Day.

No. 623. Pruning olives with a view to favoring annual bearing and better fruit. (Davis.) By G. L. Philp and W. P. Tufts.

No. 628. Experiments on the comparative effect of different methods of pruning on different varieties and soils. (Mountain View and various counties.) By A. H. Hendrickson.

No. 633. Moisture requirements of deciduous orchards. (Davis and Mountain View.) (Coöperation with Division of Irrigation Investigations.) Experiments with a young prune orchard at Davis and with various young deciduous trees in potometers to study the effects of irrigation with special reference to growth and bearing. By A. H. Hendrickson and Frank Adams. A. Irrigation studies with the Delhi Muir peach orchard. A study of the response of peach trees to different irrigation treatments under San Joaquin Valley conditions. By A. H. Hendrickson.

No. 639. Fundamental studies upon metabolic activities of fruits with special reference to their ripening and keeping in cold storage. (Berkeley.) A study to determine whether or not the ripening of green oranges may be hastened as effectively by keeping them in carbon dioxide gas for 48 to 172 hours, as by the sweating method, where the fruit is subjected to the fumes from kerosene oil stoves. By E. L. Overholser and L. P. Latimer.

No. 644. A study of the control of the peach twig borer (*Anarsia lineatella*, Zeller). (Davis and various counties.) An investigation into the life history and methods of control of the peach twig-borer. By W. P. Duruz.

No. 724. General investigations in plant physiology in relation to horticulture. (Berkeley and Davis.) A study of the rest period of deciduous fruit trees. By W. P. Tufts and S. H. Cameron.

Poultry Husbandry

No. 677. Miscellaneous poultry investigations. (Davis.) By J. E. Dougherty and S. S. Gossman.

Rural Institutions

No. 695. A study of the relation of closer settlement within irrigation projects to the feasibility and financial success of such projects. (Berkeley and various counties.) By Elwood Mead.

SOIL TECHNOLOGY

No. 446. Study of soil factors relating to the growth of alfalfa on certain areas at Davis. By R. E. Storie.

No. 552. Soil survey of the El Centro area. By A. T. Strahorn.

No. 593. Soil survey of the Shasta Valley area. By. E. B. Watson.

No. 643. Soil survey of the Victorville area. By A. E. Kocher.

No. 669. Soil survey of the Lancaster area. By S. W. Cosby.

No. 671. Soil survey of the Palo Verde Valley area. By A. E. Kocher.

No. 679A. Soil survey of the Gilroy area. By S. W. Cosby.

No. 679B. Soil survey of the Hollister area. By S. W. Cosby.

No. 679C. Soil survey of the Coachella Valley area. By A. E. Kocher.

No. 679D. Soil survey of the Auburn area. By M. H. Lapham.

No. 711. Study of the soil conditions in Placer County as a possible cause of injury to orchards. By C. F. Shaw and R. E. Storie.

VETERINARY SCIENCE

No. 24. A study of the causes and means of preventing the spread of tuberculosis in cattle and hogs in California. (Berkeley.) A study of the effect of environmental conditions in the spread of tuberculosis prosecuted under control conditions in the laboratory to check field trials. By J. Traum.

No. 59. A record of the results of hog cholera immunization at the University Farm. (Davis.) By F. M. Hayes.

No. 61. Certified dairy inspections. (Dixon, San Anselmo, Knightson, and Berkeley.) Routine sanitary inspections of certified dairies for which the University receives stipulated fees. By C. D. Carpenter.

No. 62. Tuberculin testing of cows in certified dairies. (See Project No. 61.) By C. D. Carpenter.

No. 63. Bacteriological examinations of certified milk. (Berkeley.) By C. D. Carpenter.

No. 160. Death of animals and cases of serious sickness. (Davis.) A project covering the animal clinic at the University Farm. By F. M. Hayes.

No. 312. Investigations of roup (*Avian diphtheria*) and chicken-pox (*Epithelioma contagiosum*). (Berkeley and Petaluma). By J. R. Beach.

No. 313. Miscellaneous poultry disease investigations in California. The work of the Avian Pathology Laboratory at Petaluma. By J. R. Beach, C. D. Carpenter, and J. C. Corl.

No. 314. Coöperative work in hog cholera. Educational work in hog cholera and other diseases of swine by Dr. Robert Jay, U. S. Bureau of Animal Industry in coöperation with the Division of Animal Industry, State Department of Agriculture.

No. 656. Abortion investigations. A. A study of immunity and the carrier problem in bovine abortion. (Berkeley.) By G. H. Hart, J. Traum, and C. M. Carpenter. B. A study of abortion in University Farm cattle. (Davis.) By F. M. Hayes and E. H. Barger. C. Abortion disease experiments with young calves. (Berkeley.) A study of the location of *Bact. abortum* organism in the bodies of calves drinking artificially-infected milk, also the effect of the ingestion or withdrawal of colostrum as a factor. By G. H. Hart and C. M. Carpenter.

Viticulture and Fruit Products

No. 114. Preparation of collection of olive trees at Davis, Kearney, and Imperial and of specimens at Berkeley. A new collection has been planted at Davis consisting of 25 varieties including the promising Algerian varieties Bidh el Hamman, Saiali Magloub, Baroumi de Sousse, Grosse Aberkane, Chetoui and Zarazi. By L. O. Bonnet.

No. 322. Methods of making glace fruits. (Berkeley.) Includes a study of the use of fruit in confections. By W. V. Cruess, J. B. Vance, and J. G. Brown.

No. 332. Methods of preparing various fruit juices and syrups. (Berkeley.) Includes development of methods of preparing carbonated beverages from fruits and their application to commercial production. By W. V. Cruess, J. H. Irish, and J. G. Brown.

No. 371. Comparison of the effects of long and short pruning on varieties which are commonly pruned both ways. (Various counties.) By H. E. Jacob.

No. 516. New methods of packing dried fruits. (Berkeley and various counties.) The causes of the spoiling of dried raisins and the crystallization in canned raisins have been determined during the year and methods of control worked out. By W. V. Cruess and W. B. Maher.

No. 517. A study of the maximum water content of dried fruits. (Berkeley and Davis.) Carton packed dried fruits were found to lose moisture rapidly when stored in the laboratory and to cause the packages to drop below the weights declared on the label. Studies are now under way to minimize this loss. By A. W. Christie.

No. 526. A survey of the deciduous fruit drying industry of the state. (Berkeley, Davis, and various counties.) Has included a compilation of data on the relative cost of sun-drying and dehydration, together with a study of equipment and methods. By A. W. Christie, L. C. Barnard, and E. H. Guthier.

No. 527. Effects of sulfuring on fruit tissues and its possible relation to the palatability of the dried product. (Berkeley.) (See Pomology Division.) By W. V. Cruess and E. L. Overholser.

No. 530. Study of equipment for drying and curing deciduous fruits on a commercial scale. (Various counties.) Includes field studies of various dehydraters with a view to increased efficiency. By A. W. Christie.

No. 604. Storage of fruits at low temperatures for preserving, canning and soda fountain use. (Berkeley.) A study of the preservation of different fruits in the fresh condition by means of freezing temperatures; also the effect of freezing in sugar solution upon changes in chemical composition and quality. By E. L. Overholser, W. V. Cruess, and J. G. Brown.

No. 610. The effect upon the quality of olives of methods of sterilization. (Berkeley and various counties.) An investigation of the bacterial spoilage of olives during pickling. By W. V. Cruess, P. H. Waldruff, and E. H. Guthier.

No. 623B. Pruning olives with a view to favoring annual bearing and better fruit. (Davis.) By G. L. Philp and W. P. Tufts.

No. 650. Influence on the vigor of the vine of the removal of growth in the dormant season. (Davis.) The general object of this project is to segregate the influence of pruning from other influences such as bearing. By A. J. Winkler.

No. 676. The effect of various preliminary treatments and the time of planting of vine cuttings on the number and vigor of the rootings. (Davis.) By A. J. Winkler.

No. 686. Field study of the packing and shipping of table grapes with special reference to the work of the grower and packer. (Various counties.) To determine the causes and methods of prevention of losses which occur between the producer and the consumer. By F. T. Bioletti, J. H. Irish, H. E. Jacob, and J. R. Herman.

No. 687. Cordon pruning. (Davis.) To determine which varieties of table grapes are suited to cordon pruning and what modifications of the method are advisable in the different cases. By F. T. Bioletti.

No. 689. The effect of (*a*) density and (*b*) arrangement of planting upon the vigor and bearing of the vine. (Davis.) Authorities differ as to the proper density and arrangement for planting vines. This investigation aims at securing accurate data upon which definite recommendations can be made. By F. T. Bioletti and A. J. Winkler.

No. 710. Influence of the number of fruit-buds on the quality and quantity of the vine crop and on the prevalence of "waterberries" and "black measles." (Davis.) There is reason to suspect that both "waterberries" and "black measles" are due to allowing vines to bear excessive crops. The effect of long as contrasted with short pruning is being tested on Muscat, Tokay and Sultanina to determine the relation of amounts of fruiting wood to these troubles. By F. T. Bioletti and F. J. Sheppard.

No. 713. Planting and maintenance of an instruction vineyard at Davis. To afford material for the instruction of students in the best accepted practices of grape-growing including those adapted to the development of young vines and to the management of mature bearing vines of the principal commercial varieties. By F. T. Bioletti and L. O. Bonnet.

EXPERIMENT STATION PUBLICATIONS

The following list of publications for 1922–23 comprises only a portion of the published work of the staff. Of these Station publications 1,056,150 copies have been printed during the year. A printed list of all available publications of this Station has been issued twice during the year to the entire mailing list which now includes 39,859 addresses.

Reports

Report of the College of Agriculture and the Agricultural Experiment Station of the University of California, July 1, 1922, to June 30, 1923.

Bulletins

Bul. 346. Almond Pollination. W. P. Tufts and G. L. Philp.

Bul. 347. The Control of Red Spiders in Deciduous Orchards. E. R. deOng.

Bul. 348. Pruning Young Olive Trees. F. T. Bioletti.

Bul. 349. A Study of Sidedraft and Tractor Hitches. A. H. Hoffman.

Bul. 350. Agriculture in Cut-Over Redwood Lands. W. T. Clarke.

Bul. 351. California State Dairy Cow Competition, 1920–22. F. W. Woll.

Bul. 352. Further Experiments in Plum Pollination. A. H. Hendrickson.

Bul. 353. Bovine Infectious Abortion and Associated Diseases of Cattle and New-Born Calves. G. H. Hart, F. M. Hayes and Jacob Traum.

Bul. 354. Results of Rice Experiments in 1922. C. F. Dunshee.

Bul. 355. The Peach Twig-Borer. W. P. Duruz.

Bul. 356. Observations on Some Rice Weeds in California. P. B. Kennedy.

Bul. 357. A Self-Mixing Dusting Machine for Applying Dry Insecticides and Fungicides. R. E. Smith and J. P. Martin.

Bul. 358. Black Measles, Water Berries, and Related Vine Troubles. F. T. Bioletti.

Bul. 359. Fruit Beverage Investigations. W. V. Cruess and J. H. Irish.

Bul. 360. Gum Diseases of Citrus Trees in California. H. S. Fawcett.

Bul. 361. Preliminary Yield Tables for Second Growth Redwood. Donald Bruce.

Bul. 362. Dust and the Tractor Engine. A. H. Hoffman.

Bul. 363. The Pruning of Citrus Trees in California. R. W. Hodgson.

Bul. 364. Fungicidal Dusts for the Control of Bunt. W. W. Mackie and F. N. Briggs.

Bul. 365. Avocado Culture in California. K. Ryerson, M. E. Jaffa and Harold Goss.

Bul. 366. Turkish Tobacco Culture, Curing and Marketing. W. T. Clarke.

Bul. 367. Methods of Harvesting and Irrigation in Relation to Moldy Walnuts. L. D. Batchelor.

CIRCULARS

Circ. 250. Measurement of Irrigation Water on the Farm. H. A. Wadsworth.

Circ. 251. Recommendations Concerning the Common Diseases and Parasites of Poultry in California. J. R. Beach and S. B. Freeborn.

Circ. 252. Supports for Vines. F. T. Bioletti.

Circ. 253. Vineyard Plans. F. T. Bioletti.

Circ. 254. The Use of Artificial Light to Increase Winter Egg Production. J. E. Dougherty.

Circ. 255. Leguminous Plants as Organic Fertilizers in California Agriculture. P. B. Kennedy.

Circ. 256. The Control of Wild Morning Glory. C. C. Barnum.

Circ. 257. The Small-Seeded Horse Bean. P. B. Kennedy.

Circ. 258. Thinning Deciduous Fruits. W. P. Tufts.

Circ. 259. Pear By-Products. J. H. Irish.

Circ. 260. A Selected List of References Relating to Irrigation in California. Reid Venable.

Circ. 261. Sewing Grain Sacks. James Koeber.

Circ. 262. Cabbage Production in California. H. A. Jones.

Circ. 263. Tomato Production in California. J. T. Rosa.

Circ. 264. Preliminary Essentials to Bovine Tuberculosis Control. G. H. Hart.

Circ. 265. Plant Disease and Pest Control. W. T. Horne, E. O. Essig, and W. B. Herms.

Circ. 266. Analyzing the Citrus Orchard by means of Simple Tree Records. R. W. Hodgson.

Circ. 267. The Tendency of Tractors to Rise in Front; Causes and Remedies. A. H. Hoffman.

Technical Papers

1. The Removal of Sodium Carbonate from Soils. W. P. Kelley and E. E. Thomas.
2. The Citrus Nematode, *Tylenchulus semipcnetrans*. E. E. Thomas.
3. The Formation of Sodium Carbonate in Soils. A. B. Cummins and W. P. Kelley.
4. The Effect of Sodium Chlorid and Calcium Chlorid upon the Growth and Composition of Young Orange Trees. H. S. Reed and A. R. C. Haas.
5. Citrus Blast and Black Pit. H. S. Fawcett, W. T. Horne and A. F. Camp.
6. A Study of Deciduous Fruit Tree Root-stocks with Special Reference to their Identification. M. J. Heppner.
7. A Study of the Darkening of Apple Tissue. E. L. Overholser and W. V. Cruess.

Reprints

Bul. 277. Sudan Grass. B. A. Madson and P. B. Kennedy.

Bul. 319. Caprifigs and Caprification. I. J. Condit.

Bul. 328. Prune Growing in California. A. H. Hendrickson.

Circ. 113. Correspondence Courses in Agriculture.

Circ. 117. The Selection and Cost of a Small Pumping Plant. B. A. Etcheverry and S. T. Harding.

Circ. 129. The Control of Citrus Insects. H. J. Quayle and Hugh Knight.

Circ. 136. *Melilotus Indica* as a Green Manure Crop for California. W. M. Mertz.

Circ. 154. Irrigation Practice in Growing Small Fruits in California. Wells Hutchins.

Circ. 158. Home and Farm canning. W. V. Cruess.

Circ 160. Lettuce Growing in California. S. S. Rogers.

Circ. 164. Small Fruit Culture in California. A. H. Hendrickson.

Circ. 199. Onion Growing in California. S. S. Rogers.

Circ. 243. Marmalade Juice and Jelly Juice from Citrus Fruits. W. V. Cruess and Lal Singh.

SCIENTIFIC AND OTHER PAPERS EXCLUSIVE OF BULLETINS AND CIRCULARS

Many papers representing work and investigations carried on by the Experiment Station are published in various technical and scientific journals. The following is a list of such articles, prepared by members of the staff, that have appeared during the fiscal year 1922–23.

Adams, F.

Farmer controls balance sheet by irrigation. San Francisco Chronicle, vol. 100, p. 13. Mar. 14, 1923.

Pending irrigation and water legislation. Pacific Rural Press, vol. 105, no. 13, p. 388. Mar. 31, 1923.

Irrigation in California moving steadily forward. Calif. Digest, pp. 6–7. Oct. 4, 1922.

Adams, R. L.

Land tenancy in California. Transactions of the Commonwealth Club of Calif., vol. 17, no. 10, pp. 397–448. Nov. 1922.

Forty-eight articles on California agriculture. (Historical, scientific phases, suggestions). Published under the caption: "The Science of Agriculture." San Francisco Bulletin, published Tuesdays, Thursdays, and Saturdays from Dec. 27, 1922, to April 14, 1923, inclusive.

Allen, F. W.

The way California cherries are packed (*with* W. P. Duruz). Amer. Fruit Grower, vol. 43, no. 5, pp. 3 and 12. May 1923.

Babcock, E. B.

Case of duplicate genes in *Crepis capillaris* (L.) Wallr. (*with* J. L. Collins). Science, vol. 56, p. 392. Oct. 1922.

Inheritance of glandular pubescence in *Crepis capillaris* (L.) Wallr. (*with* J. L. Collins). Science, vol. 56, p. 393. Oct. 1922.

Our common problem. Univ. of Calif. Chronicle, vol. 24, pp. 367–374. July 1922.

Why go on crossing? Bull. of the Dahlia Society of Calif., no. 19, pp. 5 and 6. May 1923.

Barrett, J. T.

Internal decline of lemons. I. Distribution and characteristics (*with* E. T. Bartholomew and H. S. Fawcett). Amer. Jour. Botany, vol. 10, no. 2, pp. 67–71. Feb. 1923.

Comparison of citrus problems in Florida and California. Calif. Citrograph, vol. 8, no. 7, pp. 242–246. May 1923.

BARTHOLOMEW, E. T.

Altenaria rot of lemons. Calif. Citrograph, vol. 8, no. 8, pp. 262, 293, 294. June 1923.

Internal decline of lemons. I. Distribution and characteristics. Amer. Jour. of Botany, vol. 10, no. 2, pp. 67–71. Feb. 1923. II. Growth rate, water content, and acidity of lemons at different stages of maturity. Amer. Jour. of Botany, vol. 10, no. 3, pp. 117–126. Mar. 1923.

Internal decline of lemons. Calif. Citrograph, vol. 8, no. 8, p. 264. June 1923.

BATCHELOR, L. D.

Alfalfa as an inter-crop lowers walnut yields. Diamond Walnut News, vol. 5, no. 3. May–June 1923.

Extra irrigation water needed the present season. Diamond Walnut News, vol. 5, no. 2, pp. 1 and 5. March–April 1923.

The present status of the walnut industry in California. Amer. Fruit Grower, vol. 43, no. 5, p. 7. May 1923.

Poor harvesting methods cost growers thousands annually. Diamond Walnut News, vol. 5, no. 1, pp. 1–3. Jan.–Feb. 1923.

BEACH, J. R.

Autopsy of the fowl. The North American Veterinarian, vol. 3, no. 7, pp. 364–386. July 1922.

Biological preparations for poultry. The North American Veterinarian, vol. 3, no. 9, pp. 320–322. Sept. 1922.

Biological preparations used in the United States for the control of poultry diseases. National Utility Poultry Society (England), Year Book and Register, pp. 44–46. 1923.

Differential diagnosis of diseases of the head of fowls. National Poultry Jour. (London), vol. 3, no. 135, p. 424. Jan. 1923.

Intestinal parasites of poultry. The North American Veterinarian, vol. 4, no. 1, pp. 48–50. Jan. 1923.

Observations on fowl cholera. The North American Veterinarian, vol. 4, no. 6, pp. 333–337. June 1923.

Observations on the occurrence of fowl cholera in California. Poultry Science, vol. 1, no. 6, pp. 186–195. Sept. 1922.

BECKETT, S. H.

Modern methods of irrigating land by means of concrete pipe. Concrete Pipe for Irrigation, published by Portland Cement Association, pp. 19–23. September. 1922.

BELTON, H. L.

Making a small concrete manure box. Farm and orchard section, Los Angeles Examiner, June 10, 1923.

Sewage problem on farm is solved by use of septic tank. Sacramento Bee, Feb. 10, 1923.

Same. Pacific Dairy Review, Feb. 8, 1923.
Same. Brawley News, Feb. 8, 1923.
Same. Calif. Farmer, Feb. 16, 1923.
Same. Fresno Bee, Feb. 10, 1923.
Same. Ventura Free Press, Feb. 7, 1923.
Same. Monrovia News, Mar. 1, 1923.
Same. La Verne Leader, Mar. 22, 1923.

BIOLETTI, F. T.

Grape growing in San Sacjuadino County. Calif. Grape Grower, vol. 3, no. 11, p. 9. Nov. 1922.

Grape growing in the Oroville region. Oroville Register, Sept. 26, 1922.

Same. Oroville Mercury, Sept. 26, 1922.

How to manage a young vineyard. Orchard and farm section, Los Angeles Times, May 6, 1923.

Methods of planting a vineyard. Orchard and farm section, Los Angeles Times, Mar. 18, 1923.

Observations on grape growing in the Rogue River Valley. Grant's Pass Daily Courier, Oct. 14, 1922.

Bringing a young vineyard into bearing. Orchard and farm section, Los Angeles Times, June 24, 1923.

Some defects of the black monukka. Associated Grower, vol. 5, no. 1, pp. 24–25. Jan. 1923.

Tokay grapes in the Rogue River Valley. Courier, Oregon, Sept. 23, 1922.

Same. Observer, Oregon, Sept. 27, 1922.

Vampyrus Ampelophagus. Calif. Grape Grower, vol. 3, no. 7, p. 11. July 1922.

Vampyrus Ampelophagus. Calif. Grape Grower, vol. 3, no. 8, p. 9. Aug. 1922.

BONNET, L. O.

Cultivation of vineyards. Calif. Grape Grower, vol. 4, no. 3, p. 3. Mar. 1923.

Cultural problems of olive Growing. Proceedings of Second Annual Processors' Conference. May 1923.

The emperor grape. Calif. Grape Grower, vol. 3, no. 11, p. 6. Nov. 1922.

Frosts and control measures. Calif. Grape Grower, vol. 4, no. 4, p. 2. Apr. 1923.

Fundamentals of vine pruning. Fresno Grape Growers' Institute. Jan. 1923.

Girdling vines. Calif. Grape Grower, vol. 4, no. 5, p. 6. May 1923.

Grape structure—Its significance. Calif. Grape Grower, vol. 3, no. 9, p. 9. Sept. 1922.

Making and conserving cuttings. Calif. Grape Grower, vol. 3, no. 12, p. 14. Dec. 1922.

Oidium and sulfuring. Calif. Grape Grower, vol. 4, no. 6, p. 8. June 1923.

Phylloxera and apoplexy. Calif. Grape Grower, vol. 3, no. 8, p. 6. Aug. 1922.

Preparation of the ground for planting. Calif. Grape Grower, vol. 4, no. 1, p. 12. Jan. 1923.

Pruning new varieties of grapes. Calif. Grape Grower, vol. 4, no. 2, p. 3. Feb. 1923.

Timely vineyard operations. Calif. Grape Grower, vol. 4, no. 3, p. 6. July 1922.

When are grapes ripe? Calif. Grape Grower, vol. 3, no. 10, p. 8. Oct. 1922.

BRUCE, D.

Perpetual supply of redwood. Amer. Lumberman, no. 2469, pp. 54–55. Sept. 9, 1922.

Light burning—Report of the Calif. Forestry Committee. Jour. of Forestry, vol. 21, no. 2, pp. 129–133. Feb. 1923.

New era opening in timber industry. San Francisco Chronicle (Progressive Calif. number), 30 K. Mar. 14, 1923.

BURD, J. S.

Important aspect of phosphate behavior in soils (*with* J. C. Martin). Science (in press), 3 pp. ms. 1923.

Place of the experiment station. Univ. of Calif. Chronicle, vol. 24, no. 3, pp. 375–387. July, 1922.

Water displacement of soils and the soil solution (*with* J. C. Martin). Jour. of Agri. Sci. (Eng.) (in press), 39 pp. ms. 1923.

BUTTERFIELD, H. M.

Blue stem of the raspberry. Pacific Rural Press. vol. 105, no. 4, p. 97. Jan. 27, 1923.

Red berry of the Himalaya. Pacific Rural Press, vol. 105, no. 4, p. 99. Jan. 27, 1923.

Strange tales from the farm—The French prune. Lucretia Dewberry. Calif. Countryman, vol. 9, no. 4, p. 7. Apr. 1923.

CARLSON, F. A.

Some relations of organic matter in soils. Cornell Univ. Agri. Exp. Sta., Memoir 61, pp. 1–27. Sept. 1922.

CHRISTIE, A. W.

Arrangement of a prune dehydrater (*with* G. B. Ridley). Sunsweet Standard, vol. 6, no. 10, p. 12. Mar. 1923.

Same. Jour. of the Amer. Soc. Heat. and Vent. Eng., vol. 29, no. 3, pp. 283–288. Apr. 1923.

Canning of asparagus (*with* W. V. Cruess). The Canning Age, vol. 4, no. 4, pp. 12–17. Apr. 1923.

Dehydrated pumpkin flour. Amer. Food Jour., vol. 17, no. 7, pp. 7, 8, 32. July 1922.

Dehydration of prunes. Sunsweet Standard, vol. 6, no. 7, pp. 12, 13, 29, 30. Dec. 1922.

Same. Pacific Rural Press, vol. 104, no. 22, pp. 588, 589. Nov. 25, 1922.

Dehydration of walnuts. Calif. Cultivator, vol. 60, no. 11, p. 306. Mar. 17, 1923.

Same. Diamond Walnut News, vol. 5, no. 2, pp. 9, 11. Mar. 1923.

Hydrometry of syrups and brines. Western Canner and Packer, vol. 14, no. 10, pp. 28, 29. Feb. 1923.

Laboratory manual of fruit and vegetable products (*with* W. V. Cruess). McGraw-Hill Book Co., Inc., 106 pp. Sept. 1922.

Sun drying peaches. Associated Grower, vol. 5, no. 3, pp. 7, 24, 25, 26. Mar. 1923.

California dehydration statistics for 1922. Sunsweet Standard, vol. 7, no. 1, pp. 10, 11. June 1923.

CLAUSEN, R. E.

Interspecific hybridization in *Nicotiana.* I. On the results of backcrossing the F_1 *sylvestris-Tabacum* hybrids to *sylvestris* (*with* T. H. Goodspeed). Univ. Calif. Publ. Bot., vol. 11, no. 1, pp. 1–30. Aug. 1922.

The inheritance of ski wings in *Drosophila melanogaster* (*with* J. L. Collins). Genetics, vol. 7, no. 4, pp. 385–426. July 1922.

Inheritance in *Drosophila hydei.* I. White and vermilion eye colors. Amer. Naturalist, vol. 57, no. 1, pp. 52–58. Jan.–Feb. 1923.

Inheritance in *Nicotiana Tabacum.* III. The origin of two periclinal chimeras by bud variation (*with* T. H. Goodspeed). Genetics, vol. 8, no. 2, pp. 97–105. Mar. 1923.

COLLINS, J. L.

A case of duplicate genes in *Crepis capillaris* (L) Wallr. (*with* E. B. Babcock). Science, vol. 56, no. 1449, p. 392. Oct. 1922.

Culture of *Crepis* for genetic investigations. Jour. Hered., vol. 13, no. 7, pp. 329–336. July 1922.

Inheritance of glandular pubescence in *Crepis capillaris* (L) Wallr. (*with* E. B. Babcock). Science, vol. 56, no. 1449, p. 393. Oct. 1922.

The inheritance of ski wings in *Drosophila melanogaster* (*with* R. E. Clausen). Genetics, vol. 7, no. 4, pp. 385–426. July 1922.

Interspecific hybrids in *Crepis*. II. A preliminary report on the results of hybridizing *Crepis setosa* Hall (N = 4) with *C. capillaris* (L) Wallr. (N = 3) and with *C. biennis* L. (N = 20) (*with* Margaret C. Mann). Genetics, vol. 8, no. 3. May 1923.

CRUESS, W. V.

Advantages of canning prunes fresh. The Canner, vol. 56, no. 15, p. 27. June 23, 1923.

Bacterial spoilage of canned foods. The Canner, vol. 56, no. 25, pp. 27–30. June 16, 1923.

Canning of asparagus. The Canning Age, vol. 4, no. 4, pp. 12–17. Apr. 1923.

Carbonated grape beverages. The Associated Grower, vol. 4, no. 3, p. 22. Oct. 1922.

Fruit beverage investigations. The Beverage Jour., vol. 59, no. 3, pp. 43–52. Mar. 1923.

Same. The Beverage Jour., vol. 59, no. 4, pp. 64–70. Apr. 1923.

Fruit by-products. Calif. Cultivator, vol. 59, no. 16, pp. 387–394. Oct. 14, 19, 1922.

Same. Oregon Grower, vol. 4, no. 10, pp. 22–23. May 1923.

Same. Proceedings Second Annual Placer County Fruit Growers' Con., vol. 2, pp. 49–57. Oct. 4, 1922.

Fruit growers conference. Calif. Cultivator, vol. 59, no. 19, p. 471. Nov. 4, 1922.

Home canning of fruits and vegetables. Calif. Cultivator, vol. 60, no. 20, pp. 583–591. May 19, 1923.

Laboratory manual of fruit and vegetable products (*with* A. W. Christie). McGraw-Hill Book Co., Inc., 106 pp. Sept. 1922.

Lye peeling of raw products for canning. The Canner, vol. 56, no. 20, pp. 27–30. May 12, 1923.

More profit per acre. Sunsweet Standard, vol. 6, no. 6, pp. 18, 19. Nov. 1922.

New fruit beverages. Calif. Cultivator, vol. 59, no. 7, pp. 149, 156. Aug. 12, 1922.

New fruit confections. Western Confectioner, vol. 9, no. 4, p. 46. Jan. 1923.

New fruit drinks. The Beverage Jour., vol. 58, no. 8, pp. 35–39. Aug. 15, 1922.

Preparation of fruit syrups for bottlers' use. The Beverage Jour., vol. 58, no. 12, pp. 35–39. Dec. 15, 1922.

Same. Beverage News, vol. 10, no. 5, pp. 17–20. Jan. 15, 1923.

Same. National Bottlers' Gazette, vol. 41, no. 491, pp. 110–112, 114, 116, and 118. Jan. 15, 1923.

Preservation of grape juice. Calif. Grape Grower, vol. 3, no. 10, pp. 2–3. Oct. 1, 1922.

Same. Calif. Cultivator, vol. 59, no. 15, p. 358. Oct. 7, 1922.

Same. Mimeographed directions. pp. 1–6. Sept. 8, 1922.

Preserving fruits and vegetables for exhibition. Calif. Cultivator, vol. 60, no. 19, p. 553. May 12, 1923.

Pure fruit drinks. The Countryman, vol. 8, no. 7, pp. 5–6. Nov. 1922.

Raisin by-products. Amer. Vinegar Industry and Fruit Products' Jour., vol. 2, no. 7, pp. 14–16. Apr. 1923.

Same. Associated Grower, vol. 5, no. 4, pp. 12, 26. Apr. 1923.

Ripe olives in California. The Canning Age, vol. 3, no. 9, pp. 5–9, 43. Sept. 1922.

Ripe olive returns to favor. Calif. Cultivator, vol. 65, no. 10, p. 223. Sept. 2, 1922.

Safe methods of home canning. Calif. Cultivator, vol. 69, no. 1, p. 5. July 1, 1922.

Save money by canning without sugar. Calif. Cultivator, vol. 10, no. 19, pp. 551, 558. May 12, 1923.

Some factors in the fermentation of vinegar stock. The Canner, vol. 55, no. 10, pp. 46–48. Sept. 2, 1922.

Use of the microscope in the cannery. The Canner, vol. 56, no. 13, pp. 27–29. Mar. 24, 1923.

Vinegar analysis for canners. Western Canner and Packer, vol. 14, no. 10, p. 118. Feb. 1923.

Day, L. H.

Control of pear blight. Sacramento Bee, vol. 133, no. 21, p. 597. Jan. 13, 1923.

Control of pear blight in California. Amer. Fruit Growers' Magazine, vol. 4, no. 6. June 1923.

Davis, A. R.

Composition of the plant in relation to the absorption of ions (*with* D. R. Hoagland). Jour. Genl. Physiology, vol. 5, no. 5, pp. 629–646. May 20, 1923.

Feeding power of plants (*with* D. R. Hoagland and C. B. Lipman). Science, vol. 57, no. 1471, pp. 299–301. Mar. 9, 1923.

deOng, E. R.

Relation of hard and alkaline waters to the preparation and dilution of sprays and dips. Jour. Economic Entomology, vol. 15, no. 5, pp. 339–345. Oct. 1922.

Dore, W. H.

Digestion of wood by *Teredo navalis* (*with* Robert C. Miller). Univ. Calif. Publ. Zoology, vol. 23, no. 1, pp. 383–400, pl. 18. Feb. 1923.

Dougherty, J. E.

Brooding chicks artificially. Calif. Farmer, vol. 26, no. 4, p. 16. Feb. 15, 1923.

Does it pay to caponize? Calif. Countryman, vol. 9, no. 5, pp. 7, 24. May 1923.

Is the poultry industry expanding too rapidly? Calif. Farmer, vol. 26, no. 8, p. 5. Apr. 15, 1923.

The poultry industry in California. Calif. Farmer, vol. 26, no. 1, p. 3. Jan. 1, 1923.

Protein—Its value for poultry. Poultry Science, vol. 2, no. 3, pp. 85–89. Mar. 1923.

Requirements of a brooding system. Calif. Farmer, vol. 26, no. 7, p. 12. April 1, 1923.

What does a feed tag mean to you? Calif. Farmer, vol. 26, no. 10, p. 12. May 15, 1923.

DUGGAR, J. F.

Agriculture for southern schools. Macmillan Co., New York, 364 pp., 240 figs. 1923.

Teachers' handbook—to accompany—Agriculture for southern schools. Macmillan Co., New York, 66 pp. 1923.

DURUZ, W. P.

Getting the fruit to market. Calif. Countryman, vol. 9, no. 3, pp. 4, 22. Mar. 1923.

Handling California fruit for shipment. Better Fruit, vol. 17, no. 5, pp. 5, 6, 22. Nov. 1922.

Peach twig borer experiments in California. Seventh Ann. Meeting Pac. Slope Branch of the Amer. Association of Economic Entomologists—Jour. of Economic Entomology, vol. 15, no. 6, pp. 395–400. Dec. 1922.

Peach twig borer experiments in Placer County. Addresses at Second Annual Placer County Fruit Growers' Convention, pp. 27–31. Oct. 1922.

Spraying deciduous fruit trees. Vacaville Reporter, vol. 40, no. 49, pp. 3, 8. Dec. 1922.

Way California cherries are packed (*with* F. W. Allen). Amer. Fruit Grower, vol. 63, no. 5, pp. 1–12. May 1923.

ESSIG, E. O.

Artichoke plume moth. Mo. Bull. Calif. State Dept. Agri., vol. 11, nos. 5–6, pp. 454–456. May–June, 1922.

Insect notes from Laguna Beach, California. P. C. Jour. Ent. and Zool., vol. 14, no. 4, pp. 75–78. Dec. 1922.

Nematodes attacking dahlia tubers. Mo. Bull. Calif. State Dept. Agri., vol. 11, nos. 5–6. pp. 465–466. May–June 1922.

New aphis on California sage. P. C. Jour. Ent. and Zool., vol. 14, no. 3, pp. 61–62. Sept. 1922.

Note on two new blister mites. Mo. Bull. Calif. State Dept. Agri., vol. 11, nos. 5–6, p. 466. May–June 1922.

Para-dichlorobenzene—A new soil fumigant. Orchard and farm section, Los Angeles Examiner, Mar. 4, 1923.

Preventing red-berry disease. Orchard and farm section, Los Angeles Examiner, Apr. 15, 1923.

FARRALL, A. W.

Care of electric motors. Pacific Dairy Review, vol. 27, p. 8. May 17, 1923.

Dairy students study mechanical side of manufacture. Pacific Dairy Review, vol. 10, p. 8. Mar. 8, 1923.

Dairy industry students at University Farm study mechanical side of dairy manufacture. Calif Dairyman, vol. 2, p. 6. Mar. 31, 1923.

Fawcett, H. S.

New phomopsis of citrus in California. Phytopathology, vol. 12, no. 9, Examiner, Apr. 15, 1923.

Internal decline of lemons. I. Distribution and characteristics (*with* E. T. Bartholomew and J. T. Barrett). Amer. Jour. of Botany, vol. 10, no. 2, pp. 67–71. Feb. 1923.

Fletcher, L. J.

Agricultural engineering—Why? Calif. Countryman, vol. 9, no. 4, pp. 3–4. Apr. 1923.

Factors influencing tractor development. Trans. Amer. Soc. of Agri. Eng., vol. 15, pp. 142–150. 1922.

Same. Agricultural Engineering, vol. 3, no. 11, pp. 179–182. Nov. 1922.

Same. Implement Record, vol. 20, no. 5, pp. 42–45. May 1923.

Farm Mechanics in a high school course. Calif. Countryman, vol. 9, no. 3, p. 6. Mar. 1923.

Use of power on farms in California. Sacramento Bee, vol. 133, p. 1. Feb. 3, 1923.

Watch your step. Calif. Cultivator, vol. 60, no. 14, p. 424. Apr. 7, 1923.

Same. Calif. Farmer, vol. 26, no. 8, p. 6. April 15, 1923.

Same. Calif. Citrograph, vol. 7, no. 8, p. 287. June 1923.

Flint, C. L.

Construction of models in landscape architecture. Architect and Engineer, vol. 71, no. 1, pp. 75–77. Oct. 1922.

Landscape architecture. Calif. Fruitman, vol. 3, no. 1, pp. 17–18. Jan–Feb. 1923.

Freeborn, S. B.

Control of poultry round worms. Orchard and farm section, San Francisco Examiner, p. 6, Feb. 25, 1923.

Fritz, E.

Plea for common sense in changing botanical nomenclature. Jour. of Forestry, vol. 21, no. 1, pp. 61–65. Jan. 1923.

Frost, H. B.

Heterosis and dominance of size factors in *Raphanus.* Genetics, vol. 8, no. 2, pp. 116–153. Mar. 1923.

Gericke, W. F.

Further notes on effect of extent of root systems on tillering of wheat. Bot. Gaz., vol. 75, no. 3, pp. 320–322. May, 1923.

Further notes on the growing of wheat in one-salt solutions. Soil Science, vol. 15, no. 2, pp. 69–73. Feb. 1923.

Protective power against salt injury of large root systems of wheat seedlings. Bot. Gaz., vol. 74, no. 2, pp. 204–209. Oct. 1922.

Some effects of physiological conditions on genetic characteristics of wheat. Amer. Jour. Bot., vol. 10, no. 6, pp. 275–277. June 1923.

Studies on the effect of nitrogen applied to oats at different periods of growth. Jour. Amer. Soc. Agron., vol. 14, no. 8, pp. 312–320. Nov. 1922.

Water culture experimentation. Science, vol. 56, no. 1450, pp. 421–422. Oct. 13, 1922.

HAAS, A. R. C.

Pot cultures with barley in soil from a long-time fertilizer experiment. Bot. Gaz., vol. 75, no. 1, pp. 95–102. Mar. 1923.

HALMA, F. F.

Influence of position on the production of laterals by branches. Calif. Citrograph, vol. 13, no. 5. Mar. 1923.

HAMMON, J. B.

Soil Survey of the El Centro area. Field Operations of the Bureau of Soils for 1918. 1922.

HART, G. H.

Bacterium abortum of Bang. Calif. Countryman, vol. 9, no. 1, pp. 8–9. Jan. 1923.

HAYES, F. M.

Treatment of mammitis with vaporized ether. Proc. of Calif. Vet. Med. Association, Vet. Pract. Week. Jan. 1922.

HENDRICKSON, A. H.

More about plum pollination. Proc. Second Annual Placer County Fruit Growers' Convention, pp. 31–35. Oct. 1922.

Same. Sacramento Bee, Oct. 28, 1922.

Orchardists are going into partnership with bees. Orchard and farm section, San Francisco Examiner, April 29, 1923.

Prune growing on the Pacific Coast. Proc. Amer. Pom. Soc., Thirty-ninth Biennial Meeting, pp. 45–57, 1922.

Season's most important job. Sunsweet Standard, vol. 6, no. 12, p. 12. May 1923.

When shall I plow? Sunsweet Standard, vol. 6, no. 12. Mar. 1923.

HENDRY, G. W.

Alfalfa in history. Jour. of Amer. Soc. of Agron., vol. 15, no. 5, pp. 171–176. May 1923.

Pure seed program of the University of California. Calif. Cultivator, vol. 60, no. 1, pp. 3–19. Jan. 1923.

HIBBARD, P. L.

Nitrate of lime, origin, nature and use. Pacific Rural Press, May 5, 1923.

Sulfur not a cure for nitre spots. Pacific Rural Press, Mar. 17, 1923.

HOAGLAND, D. R.

Composition of the cell sap of the plant in relation to the absorption of ions. Jour. Gen. Physiol., vol. 5, no. 5, pp. 629–646. May 20, 1923.

Feeding power of plants (*with* C. B. Lipman and A. R. Davis). Science, vol. 57, no. 1471. Mar. 9, 1923.

HOFFMAN, A. H.

Disk harrows tested at Davis. Calif. Cultivator, vol. 60, p. 255. Mar. 3, 1923.

Same. Farm and tractor section, Los Angeles Times, vol. 42, p. 9. Feb. 11, 1923.

Same. Country Life, Fresno Bee, vol. 1, p. 2. Feb. 3, 1923.

Efficiency of dust separation in air cleaners for internal combustion engines. Part I. Agri. Engineering, vol. 4, p. 89–95. June 1923.

How auto engines lose power in the high mountains. San Francisco Chronicle, Mar. 25, 1923.

Same. Motor Land, vol. 12, no. 19. Apr. 1923.

Same. Stockton Record, vol. 56, no. 7. Mar. 24, 1923.

How many tractor hours? Orchard and farm section, Los Angeles and San Francisco Examiner, Mar. 25, 1923.

Saving labor for the farm wife. Calif. Countryman, vol. 9, pp. 5, 18–20. Apr. 1923.

Where quick oil distribution saved an orange crop. Rotagravure section, Los Angeles Times, vol. 42, p. 11, April 8, 1923.

HORNE, W. T.

A phomopsis in grape fruit from the Isle of Pines, W. I., with notes on *Diplodia Natalensis.* Phytopathology, vol. 12, no. 9, pp. 414–418. Sept. 1922.

HOWARD, W. L.

Baffling orchard pest. Amer. Fruit Growers' Mag., vol. 43, no. 2, pp. 26, 27, 44, 49, 50. Feb. 1923.

European investigations. Calif. Countryman, vol. 8, no. 6, pp. 5, 22, 23. Oct. 1922.

High lights on European horticulture. Amer. Fruit Growers' Mag., vol. 42, no. 11, pp. 7, 17, 19. Nov. 1922.

Pruning dont's. Calif. Countryman, vol. 8, no. 7, pp. 5 and 21. Nov. 1922

Question of rootstocks. Proc. Amer. Pom. Soc., Thirty-ninth biennial convention, pp. 95–98, 1922.

Same. Trans. Iowa State Hort Soc., vol. 57, pp. 177–180, 1922.

Searching Europe for better tree seeds. Part I. Mo. Homestead, vol. 45, no. 29, p. 1. July 20, 1922.

Searching Europe for better tree seeds. Part II. Mo. Homestead, vol. 45, no. 30, p. 1. July 27, 1922.

HOWELL, C. E.

Horses vs. tractors. Farm and tractor section, Los Angeles Times, Dec. 3, 1922.

HUGHES, E. H.

It pays to hitch the hog to the dairy cow. Orchard and farm section, San Francisco Examiner, Feb. 25, 1923.

Marketing your barley in the pork route. Calif. Cultivator, March 17, 1923.

Rice and rice by-products as feeds for fattening swine. Proc. Meeting of the Amer. Soc. of Animal Production, pp. 59–63. Mar. 1923.

Same. Calif. Countryman, vol. 8, no. 8. Dec. 1922.

Reports of the California State Fair. Breeder's Gazette, Sept. 20, 1922.

Some side lights on Berkshire type. The Berkshire World, vol. 15, no. 1. Jan. 1923.

Swine show at the California State Fair. Calif. Cultivator, Sept. 7, 1922.

There is profit in pork. Calif. Dairyman, Nov. 2, 1922.

HUTCHISON, C. B.

Elementary course in genetics. Science, vol. 55, no. 1425, pp. 416–421. Apr. 21, 1922.

Functions of an agricultural college. Calif. Cultivator, vol. 59, no. 20, pp. 501 and 515. Nov. 11, 1922.

Linkage of certain aleurone and endosperm factors in maize and their relation to other linkage groups. Cornell Univ. Agri. Exp. Sta., Memoir 60, pp. 1425–1473. June 1922.

JAFFA, M. E.

Sea food: Its value from a food standpoint. Calif. State Board of Health Weekly Bull., vol. 1, no. 2, pp. 1–2. Sept. 23, 1922.

Sea food and its great value. San Francisco Examiner, p. 19, Oct. 19, 1922.

Vitamins in ice cream. Calif. State Board of Health Weekly Bull., vol. 1, no. 50, p. 3. Jan. 27, 1923.

Same. Calif. Cultivator, vol. 56, no. 12, p. 361. Mar. 24, 1923.

Vitamins: Truth vs. fiction. Calif. State Board of Health Weekly Bull., vol. 1, no. 20, pp. 1–2. July 1, 1922.

JONES, H. A.

Time of flower primordian formation in the onion (*Allium cepa* L.) (*with* V. R. Boswell). Proc. of Amer. Soc. for Horticultural Science, vol. 19, pp. 144–147. Dec. 1922.

KELLEY, W. P.

Variability of alkali soils. Soil Science, vol. 14, no. 3, pp. 177–189. Sept. 1922.

KENNEDY, P. B.

Grasses to save ocean lots. Orchard and farm section, Los Angeles Examiner, Jan. 28, 1923.

Improving horse beans for cover crops. Orchard and farm section, Los Angeles Examiner, Mar. 4, 1923.

KERN, O. J.

Building a temple to agriculture and country life—a series of articles. The School News and Practical Educator (Taylorville, Ill.), vol. 36, nos. 1, 2, 3, 4, 5, 6, 7, 8, 9, 10. Sept. 1922–June 1923.

Consolidated Schools. Banker-Farmer (Champaign, Ill.), vol. 9, no. 8. Aug. 1922.

Recreation and play for junior rural democracy. Jour. of Rural Education (Montpelier, Vermont), vol. 1, no. 7. Sept. 1922.

The unknown artist. St. Isidore's Plow (Portland, Oregon), vol. 1, no. 2. Dec. 1922.

KOEBER, J.

How to lengthen the life of harness. Pacific Dairy Review, vol. 27, p. 20. Apr. 19, 1923.

Repairing bearings by soldering. Country life section, Sacramento Bee, vol. 133, p. 14, Feb. 17, 1923.

LESLEY, J. W.

Genetic studies in potatoes. Jour. of Genetics, vol. 13, no. 2, 1923.

Lipman, C. B.

Report of the Board of Research. Annual Rept. of the President of the Univ. of Calif., 1921–22, vol. 16, no. 6. Dec. 1922.

Does nitrification occur in sea-water? Science, vol. 56, no. 1453. Nov. 3, 1922.

Effect of reaction on the fixation of nitrogen by azotobacter (*with* H. W. Johnson). Univ. Calif. Publ. Agri. Sci., vol. 4, no. 12, pp. 397–405. Dec. 1922.

Feeding power of plants (*with* A. R. Davis and D. R. Hoagland). Science, vol. 57, no. 1471. Mar. 9, 1923.

Further studies on the Drew hypothesis of $CaCO_3$ precipitation in sea-water. Annual Rept., Dept. of Marine Biology, Carnegie Institution of Washington Year Book, no. 21, p. 171.

Proof of the power of the wheat plant to fix atmospheric nitrogen (*with* J. K. Taylor). Science, vol. 56, no. 1456. Nov. 24, 1922.

Relation of the reaction and of salt content of the medium on nitrifying bacteria (*with* Carolyn S. Meek). Jour. Gen. Physiology, vol. 5, no. 2, pp. 195–204. Nov. 20, 1922.

Report of Committee on Revision of Methods of Soil Analysis. Association of Official Agri. Chemists, vol. 5, no. 3, p. 316. Feb. 15, 1922.

Long, J. D.

Fruit packing house with sawtooth roof. Calif. Cultivator, vol. 60, no. 18, p. 537. May 5, 1923.

Same. Calif. Farmer, vol. 26, no. 9, p. 6. May 1, 1923.

Same. Stockton Record-Herald, April 21, 1923.

Small milkhouse for the California dairyman. Pacific Dairy Review, vol. 27, no. 10, p. 10. Mar. 8, 1923.

Same. Calif. Dairyman, Mar. 3, 1923.

Same. Calif. Farmer, Mar. 1, 1923.

Same. Country life section, Sacramento Bee, vol. 133, no. 21633, p. 8. Feb. 24, 1923.

Mackie, W. W.

Copper carbonate dust controls smut safely. Pacific Rural Press, vol. 104, no. 18, p. 468. Oct. 28, 1922.

Cotton leaf miner in the Imperial Valley. Calif. Cultivator, vol. 60, no. 22, p. 648. June 2, 1923.

Olive growing in the Imperial Valley. Farm and tractor section, Los Angeles Times, June 10, 1923.

Madson, B. A.

Darso—new variety of sweet grain sorghum. Orchard and farm section, San Francisco Examiner, p. 3, June 17, 1923.

Timely suggestions on making alfalfa hay. Orchard and farm section, San Francisco Examiner, pp. 3–10, May 13, 1923.

Mann, M. C.

Occurence and hereditary behavior of two new dominant mutations in inbred strain of *Drosophila melanogaster*. Genetics, vol. 8, no. 1, pp. 27–35. July 1923.

McKibben, E. G.

Black smoke fallacy. Orchard and farm section, San Francisco Examiner, vol. 118, no. 150. p. 5. Apr. 1923.

Combining principles and practice. Pacific Dairy Review, vol. 27, no. 9, p. 10. Mar. 1, 1923.

Same. Country life section, Sacramento Bee, vol. 133, no. 21639, p. 5. Mar. 3, 1923.

Same. Farm Mechanics, vol. 8, no. 6, p. 21. Apr. 1923.

Mead, Elwood.

How to build up the rural west. Sunset Magazine, pp. 32–33, 108–111, June 1923.

Incomplete development prevents success in irrigation. Engineering News Record, p. 497, Mar. 15, 1923.

Metcalf, W.

An ancient pine cone. Amer. Forestry, vol. 29, no. 351, p. 172. Mar. 1923.

County organization for rural fire control. Calif. State Board of Forestry, Circular, 6 pp. June, 1923.

Forestry among the giants. Amer. Forestry, vol. 28, no. 347, pp. 643–654. Nov. 1922.

Prayer book in a pine tree. Amer. Forestry, vol. 29, no. 352, pp. 232–233. Apr. 1923.

Wood important part of largest stadium. The Timberman, vol. 24, no. 6, p. 34. May 1923.

Miller, R. F.

East vs. west. Calif. Countryman, vol. 9, no. 1, p. 9. Jan. 1923.

Sheep feeding trial at the Branch of the College of Agriculture. Country life section, Sacramento Bee, Mar. 24, 1923.

Moses, B. D.

Inside facts on a gas engine. Farm and tractor section, Los Angeles Times, vol. 42, p. 13, Mar. 25, 1923.

Late spark—Hot engine. Pacific Dairy Review, vol. 27, p. 12, May 31, 1923.

Moth ball theory about gasoline is declared foolish. Sacramento Bee, vol. 133, no. 21660, p. 18. Mar. 28, 1923.

Mudge, C. S.

On the endothermal reaction which accompanies the appearance of a visible curd in milks coagulated by heat (*with* A. Leighton). Jour. Bio. Chem., vol. 56, no. 1, pp. 53–73. May 1923.

Relation of vitamins to the growth of a streptococcus (*with* S. H. Ayers). Jour. Bact., vol. 7, no. 5, pp. 449–464. Sept. 1922.

Streptococci of the bovine udder (*with* S. H. Ayers). Jour. Inf. Dis., vol. 31, no. 1, pp. 40–50. July 1922.

Mulford, W.

Forestry notes. Sierra Club Bull., vol. 11, no. 4, pp. 447–452. 1923.

OVERHOLSER, E. L.

Abstracts. Botanical Gazette, vol. 11. 1922.

The amateur pomologist or fruit grower of the San Francisco Bay region. Berkeley Daily Gazette, Jan. 15, 1923.

Cold storage of plums. Western Fruit Jobber, vol. 9, no. 7, pp. 39–45. Nov. 1922.

Deciduous fruit outlook. Associated Grower, vol. 4, no. 2, p. 12. Sept. 1922.

Diseases and insects of the fruit garden. Berkeley Daily Gazette, Jan. 26, 1923.

Effects of thinning peaches. Associated Grower, vol. 5, no. 4, p. 7. Apr. 1923.

Same. Calif. Cultivator, Apr. 28, 1923.

Future outlook for California's new fruit acreage. Merced County Farm Bur., vol 2, pp. 1 and 5. July 1922.

Same. Country life section, Sacramento Bee, Sept. 18, 1922.

Same. The Calif. Digest, vol. 1, p. 4. Oct. 4, 1922.

Same. The Mo. Bull. Calif. State Dept. of Agri., vol. 11, no. 10. Oct. 1922.

Same. Calif. Fruit News, vol. 66, no. 1808, p. 13. Mar. 3, 1923.

Same. Sentinel (Lodi, Calif.), Dec. 7, 1922.

General cultural care of home fruit garden. Soil management. Berkeley Daily Gazette, Jan. 22, 1923.

John Charles Whitten—A tribute. The College Farmer, Univ. of Missouri, vol. 16, pp. 17–18. Sept. 1922.

Keeping the fig in fresh condition by low temperatures. Part II. The Associated Grower, vol. 3, no. 7, p. 13. June 1922.

Keeping pears sound. The Calif. Countryman, vol. 8, no. 7, pp. 3 and 4. Nov. 1922.

Obtaining, planting and shaping the young fruit tree. Berkeley Daily Gazette, Jan. 19, 1923.

Pecans in California. Parts I and II. Orchard and farm sections, San Francisco, and the Los Angeles Examiner, pp. 10–14, May 6, and pp. 7–8, May 13, 1923.

Storage and precooling. Orchard and Farm, Mar. 11, 1923.

Study of cold storage of Sonoma County apples (*with* J. L. Fidler). Sonoma County Farm Bureau Monthly, vol. 3, no. 6, pp. 21–22. June 1922.

Thinning beyond the experiment stage. Sacramento Bee, May 5, 1923.

Same. Fresno Bee, May 5, 1923.

Same. Santa Rosa Republican, May 10, 1923.

Varieties of deciduous fruits recommended for the home garden. Berkeley Daily Gazette, Jan. 17, 1923.

QUAYLE, H. J.

Control of codling moth in walnuts. Mo. Bull. State Dept. Agri., vol. 11, no. 7, pp. 40–42. July 1922.

Dusting vs. spraying for codling moth in walnuts. Jour. Economic Ent., vol. 15, no. 5, pp. 371–372. Oct. 1922.

Resistance of certain scale insects in certain localities to hydrocyanic acid gas fumigation. Jour. Economic Ent., vol. 15, no. 6, pp. 400–404. Dec. 1922.

RAFFETTO, L. A.

High lights of the dairy short course. Calif. Countryman, vol. 10, no. 1, p. 5. Jan. 1923.

Reed, H. S.

The pseudo-antagonism of sodium and calcium in dilute solutions (*with* A. R. C. Haas). Jour. of Agri. Research, vol. 24 (in press). May, 1923.

What can biology contribute to the world of today? Privately printed, 14 pp.

A note on the statics of cyclic growth. Pro. Nat'l Acad. Sci., vol. 9, pp. 65–67. Mar. 1923.

Roadhouse, C. L.

Serving milk in schools. Eleventh Ann. Rept. of International Assn. of Dairy and Milk Inspectors, vol. 11, pp. 160–163. Oct. 1922.

Structure and equipment of modern milk plant. Eleventh Ann. Rept. of International Assn. of Dairy and Milk Inspectors, vol. 11, pp. 181–187. Oct. 1922.

Rosa, J. T.

Note on an indirect effect of spraying potatoes with Bordeaux mixture. Amer. Jour. of Botany, vol. 10, pp. 113–116. Mar. 1923.

Rudolph, B. A.

Orchard sanitation and brown rot control. Alameda County Farm Bur. Monthly, vol. 6, no. 12, p. 14. Dec. 1922.

Preparation of Bordeaux mixture. Sunsweet Standard, vol. 6, no. 8, p. 14. Jan. 1923.

Same. Pacific Rural Press, vol. 105, no. 1, p. 6. Jan. 6, 1923.

Same. Alameda County Farm Bur. Monthly, vol. 7, no. 1, p. 9. Jan. 1923.

When to spray for brown rot of apricots. Pacific Rural Press, vol. 105, no. 5, p. 126. Feb. 3, 1923.

Same. Sunsweet Standard, vol. 6, no. 9, p. 17. Feb. 1923.

Same. Alameda County Farm Bur. Monthly, vol. 7, no. 2, p. 13. Feb. 1923.

Sampson, A. W.

Forage plants of the sunflower family. Nat'l Wool Grower, vol. 13, no. 6, pp. 15–17. June 1923.

Our native broad-leafed forage plants. Nat'l Wool Grower, vol. 13, no. 5, pp. 17–19. May 1923.

Range and pasture management. John Wiley & Sons, Inc., N. Y., 421 pp. May 1923.

Severin, H. H. P.

Control of the beet leafhopper. Experiments in the use of nicotine dust with a dusting machine conducted in California. Facts About Sugar, vol. 15, no. 7, pp. 134–135. Aug. 1922.

Control of the beet leafhopper. Is it economically a hopeless problem in California? Facts About Sugar, vol. 14, nos. 16 and 17, pp. 312–313 and 332–333. Apr. 1922.

Facts concerning migration of beet leafhopper (*Eutettix tenella* Baker) in Sacramento Valley of California (*with* A. J. Basinger). Jour. of Economic Entomology, vol. 1, no. 16, pp. 404–411. Dec. 1922.

Facts concerning natural breeding area of beet leafhopper (*Eutettix tenella* Baker) in San Joaquin Valley of California (*with* A. J. Basinger). Jour. of Economic Entomology, vol. 15, no. 6, pp. 411–419. Dec. 1922.

"Fire Ants" injurious to potatoes in California. Jour. of Economic Entomology, vol. 16, no. 1, pp. 96–97. Feb. 1923.

Infective beet leafhoppers (*Eutettix tenella* Baker) do not transmit curly leaf daily. Jour. of Economic Entomology, vol. 15, no. 4, p. 318. Aug. 1922.

Mosaic and curly leaf diseases of sugar beets. Jour. of Economic Entomology, vol. 15, no. 3, p. 247. June 1922.

Sea coast flea beetle (*Disonycha maritima* Mann.) injurious to sugar beets in Sacramento Valley. Jour. of Economic Entomology, vol. 15, no. 4, p. 312. Aug. 1922.

SHAW, C. F.

Utilization of soil surveys. Rept. of Third Ann. Meeting of the Amer. Assn. of Soil Survey Workers, vol. 1, Bull. 4, pp. 40–44. Nov. 1922.

SMITH, A.

Soil survey of the Shasta Valley Area, California. Field Operations of Bureau of Soils, 1919, pp. 99–152. 1923.

SMITH, C. O.

Pathogenicity of the olive knot organism on hosts related to the olive. Phytopathology, vol. 12, pp. 271–278. May 1922.

SURR, J. G.

Great Valley of California. Lindsay Gazette, p. 6, Nov. 3, 1922.

Notes on fertilizing citrus groves. Calif. Citrograph, vol. 8, no. 1, pp. 12–13 and 22–23. Nov. 1922.

Sierra Nevada mountains. Lindsay Gazette, pp. 11 and 14, Nov. 17, 1922.

THOMSON, R. R.

Calibration of a grain drill. Calif. Farmer, vol. 26, p. 8, Feb. 1, 1923.

Farmer's handy tool kit. Stockton Record, p. 4, May 26, 1923.

TOMSON, W. E.

College herd makes "Magna Cum Laude" record. Pacific Dairy Review, vol. 27, no. 3, p. 1–2. Jan. 18, 1923.

Remarkable cow passes on. Jersey Bull. and Dairy World, vol. 42, no. 7, pp. 330–331. Feb. 14, 1923.

University cow has established record. Country life section, Sacramento Bee, p. 2, Mar. 31, 1923.

University cows high producers. Stockton Record, p. 8, Jan. 13, 1923.

University cow makes state record. Pacific Dairy Review, vol. 32, no. 14, p. 1. Apr. 5, 1923.

University develops high producing four-year-old. Holstein-Friesian World, vol. 20, no. 21, pp. 1108–1109. May 26, 1923.

TRUE, G. H.

Fritz Wilhelm Woll. Calif. Countryman, vol. 9, no. 1, p. 11. Jan. 1923.

University range cattle experiment. Farm and Ranch Market Jour., vol. 1, no. 8, p. 7. Jan. 25, 1923.

TUFTS, W. P.

Growing the Bartlett pear in California. Oregon Grower, vol. 4, no. 9, p. 3. Apr. 1923.

Handling California peach crop. Amer. Fruit Grower, vol. 43, no. 6, p. 6. June 1923.

Identification of deciduous fruit tree root stocks (*with* M. J. Heppner). Placer County Farm Bur. Monthly, vol. 2, no. 6, p. 11. July 1922.

Making pruning grow more apricots. Sunsweet Standard, p. 14, Feb. 1923.

Pruning deciduous fruit trees of California. Country life section, Sacramento Bee, Oct. 28, 1922.

Same. Amer. Fruit Grower, vol. 42, no. 11, p. 8. Nov. 1922.

Same. Second Ann. Rept. Placer County Fruit Growers' Convention, pp. 22-27. Oct. 1922.

Spray table for Northern California. Amer. Fruit Grower, vol. 43, no. 2, p. 10. Feb. 1922.

VAILE, R. S.

Increased citrus production in Riverside. Riverside Press, Apr. 24, 1923.

Insects and diseases that attack citrus fruits in Southern California. Amer. Fruit Grower, vol. 23, no. 2, pp. 24, 25, and 44. Feb. 1923.

Irrigation practices on Tulare County soils. Lindsay Gazette, Sept. 8, 1922.

Orchard heating in California. Amer. Fruit Grower, vol. 42, no. 11, pp. 3, 12, 17. Nov. 1922.

Some effects of uniform percentage increase in freight rates on certain agricultural productions. Quarterly Jour. of Economics, vol. 36, no. 4, pp. 718–727. Aug. 1922.

Winter cover crops and frost damage. Calif. Citrograph, vol. 7, no. 12, pp. 402–403. Sept. 8, 1922.

VAN DYKE, E. C.

A study of the Lucanid Coleoptera of the Hawaiian Islands. Proc. Hawaiian Ento. Soc., vol. 5, no. 1, pp. 39–49. Oct. 1922.

A new species of Rhyncogonus (*Rhyncophorous Coleoptera*). Proc. Hawaiian Ento. Soc., vol. 5, no. 1, pp. 49–50. Oct. 1922.

New species of Coleoptera from California. Bul. Brooklyn Ento Soc., vol. 18, pp. 37–53. May 1922.

VOORHIES, E. C.

California farmer has the help of State University. San Francisco Chronicle, p. 12, Mar. 14, 1923.

Report of the Director of Resident Instruction. Annual Report, College of Agriculture, University of California, July 1922, pp. 215–218.

Instruction in the College of Agriculture of the University of California. Humboldt Beacon, Nov. 2, 1922.

The University Farm at Davis. Blue and Gold, vol. 50, pp. 52–53. May 1923.

What becomes of the college graduate? Pacific Rural Press, July 29, 1922.

WADSWORTH, H. A.

Aim of irrigation. Farm and tractor section, Los Angeles Times, Oct. 1, 1922.

Alfalfa yields increase with application of water. Farm and tractor section, Los Angeles Times, Feb. 17, 1923.

Design of alfalfa irrigation structures. Farm and tractor section, Los Angeles Times, July 23, 1922.

Design of farm ditches. Farm and tractor section, Los Angeles Times, Mar. 5, 1923.

Discharge through adjustable submerged orifices. Engineering News Record, vol. 90, no. 7, pp. 308–309. Feb. 15, 1923.

Distribution of moisture from furrows. Farm and tractor section, Los Angeles Times, Oct. 8, 1922.

Hints on the economical design of small pumping plants. Farm and tractor section, Los Angeles Times, Aug. 27, 1922.

Preparation of land for irrigation of alfalfa. Farm and tractor section, Los Angeles Times, July 23, 1922.

WANK, M. E.

Soil survey of the Shasta Valley Area, California. Field Operations of Bureau of Soils, 1919, pp. 99–152. 1923.

WEBBER, H. J.

Long staple cotton should be raised. Wall Street Jour (New York City), Jan 7, 1922.

Citrus root-stock problems. Calif. Citrograph, vol. 7, no. 12, p. 381. Oct. 1922.

Same. Lindsay Gazette, p. 11, Sept. 8, 1922.

Proper root-stock required for maximum citrus crops. Citrus Leaves, vol. 2, no. 11, p. 4 (5 figs.). Nov. 1922.

Citrus-Arten. Handbuch der Landwirtschaftlichen Pflanzenzuchtung. Berlin (Paul Parey), vol. 5, chap. 4, pp. 112–130. 1922.

The relation of stocks to scions with special reference to citrus. Proc. Amer. Soc. for Hort. Sci., pp. 129–139. 1922.

The June drop of oranges. Calif. Citrograph, vol. 8, no. 6, p. 183. Apr. 1923.

WEIR, W. W.

Special features of the drainage of irrigated lands. Agri. Engineering, vol. 3, no. 11, pp. 182–186. Nov. 1922.

Same. Part I. National Reclamation Magazine, vol. 1, no. 11, pp. 183–184, 204; no. 12, pp. 210, 211. Nov.–Dec. 1922.

WICKSON, E. J.

California garden flowers, shrubs, trees, and vines. Second edition revised and extended. Pacific Rural Press, San Francisco, 255 pp. Mar. 1, 1923.

California vegetables in garden and field. A manual of practice with and without irrigation for semi-tropical countries. Fifth edition, fully revised. Pacific Rural Press, San Francisco, 318 pp. Oct. 1922.

Rural California. The Macmillan Co., New York, 399 pp. Jan. 1923.

WILSON, J. F.

California students stage wool sale. Nat'l Wool Grower, vol. 13, no. 5, p. 36. May 1923.

California wool exhibit. Nat'l Wool Grower, vol. 12, no. 10, p. 32. Oct. 1922.

Competition in fleece wools at California Fair. Nat'l Wool Grower, vol. 12, no. 10, p. 35. Oct. 1922.

Official shearing test for advanced register. Nat'l Wool Grower, vol. 13, no. 5, p. 44. May 1923.

Meeting of California wool growers at Davis. Nat'l Wool Grower, vol. 13, no. 3, p. 19. Mar. 1923.

Wool scouring at home. Pacific Rural Press, vol. 105, no. 26, p. 789. June 30, 1923.

WINKLER, A. J.

Study of the internal browning of the Yellow Newtown Apple. Jour. of Agric. Research, vol. 24, no. 2, pp. 165–184. Apr. 1923.

ZINK, W. L.

Oxy-Acetylene repairing. Tractor and Gas Engine Review, vol. 16, no. 6, pp. 30–31. June 1923.

Oxy-Acetylene repairing of farm equipment. Country life section, Sacramento Bee, vol. 133, no. 21699. May 12, 1923.

REPORT OF THE ACTING DIRECTOR OF RESIDENT INSTRUCTION

By Edwin C. Voorhies

The year 1922–23 marked a distinct increase in regularity in the work of the students in the College of Agriculture. In the annual report for 1921–22 the statement was made that the "Study Lists Committee reports few petitions from students, showing less tendency to avoid regular programs." The tendency toward regularity has progressed to the point where students can be said to be as regular in their work as can be expected. The absence of any considerable changes in the requirements for graduation has contributed greatly to this regularity. Changes in graduation requirements should be made only after the most careful study and deliberation.

The Acting Director of Resident Instruction has been enabled by the lessening of routine work and unnecessary committee meetings to devote more time to the tasks which lie within the province of his office. Investigations concerning the residence and previous preparation of entering students have been made and the results sent to members of the staff. Occupational statistics of both degree and non-degree alumni have been obtained and classified. Comparative studies are being made with reference to the curricula of the various agricultural colleges in the United States.

Improvement of College Teaching.—Under the leadership of Professor F. L. Griffin of the Division of Agricultural Education, a Committee on College Teaching formulated a report which was adopted by the Department of Agriculture. The main recommendations of this report are as follows:

1. Each division should hold one or more staff meetings each semester for the express purpose of discussing the improvement of the teaching of the particular subject matter of that division.

2. The establishment of a seminar on college teaching, at Berkeley and at Davis.

3. Filing of an outline of each course offered with the Director of Resident Instruction.

4. Visiting of courses given by instructors in other divisions or departments for the purpose of strengthening teaching as well, by members of the Department of Agriculture.

The Executive Committee of the Council of Agriculture has been giving attention to the grading system in use in the College. Tabulations made during the past year by Bruce and Voorhies clearly show the need for a more uniform grading system. Members of the staff have requested that the committee consider the question of a percentage basis for giving the grades now in use.

Further revision of courses has taken place during the past year. This revision has been in many cases brought about by the listing of certain courses heretofore in the upper division in the freshman and sophomore years. The work in Pomology and Agronomy, both at Berkeley and at Davis, has been reorganized. Divisions have eliminated many courses in the past year. It is felt that the present number can still be reduced with a corresponding increase in efficiency.

Several of the courses now given could readily be dropped without a distinct loss to the curriculum. The undergraduate curriculum is not intended to develop specialists. The motto of our divisions should be "Fewer and Better Courses" rather than "More Courses." At the present time if certain courses were dropped members of the divisions concerned would have more time available for research and extension work.

Improvement of Relations with High Schools.—An effort has been made during the past year to establish closer relations with the high schools of the state. The acting director has endeavored to visit a number of high schools each semester in an effort to inform teachers and students of the work of the College. That this has been welcomed by the high school authorities is shown by the number of invitations received from high schools for this service.

Griffin and Crandall of the Division of Agricultural Education have been responsible to a high degree for the coöperation between the high schools, particularly their agricultural departments and the College of Agriculture. The number of graduates of the College teaching in the high schools of the state is constantly increasing.

In an effort to give more effective instruction to students fitting themselves for the position of Farm Mechanics teachers in secondary schools, Fletcher visited some 40 high schools where Farm Mechanics is offered. The methods used, equipment, content of courses, types of buildings, project work, cost of instruction, etc., have been studied.

Size of Classes.—Contrary to an opinion prevailing throughout the state, classes in the College of Agriculture are not large. The following table gives the enrollment in undergraduate classes of varying size:

No. of Students	Berkeley	Davis	Total
1–5	19	9	28
6–10	19	8	27
11–20	13	14	27
21–30	1	5	6
31–40	1	6	7
41–50	2	3	5
51–60	1	3	4
61–70	1	0	1
71–80	1	1	2
81–90	....	1	1
91–100	....	1	1

Enrollment.—The entering class of 1922–23 was larger than that of 1921–22 and was characterized by the large number of students with advanced standing although the number of freshmen entering for the first time showed a substantial increase.

Students Enrolled in the College of Agriculture

Undergraduates

1921–1922

	1st year	2nd year	3rd year	4th year	Specials	Total	Grand Total
Men	112	115*	128	137	17	509	
Women	7	10	5	9	3	34	543

1922–1923

	1st year	2nd year	3rd year	4th year	Specials	Total	Grand Total
Men	150	104	124	132	14	524	
Women	5	9	5	5	2	26	550

Graduates

	Men	Women	Total
1921–1922	82	4	86
1922–1923	90	3	93

Total, Graduates and Undergraduates

1921–1922	591	38	629
1922–1923	550	93	643

One hundred and ten students received the degree of bachelor of science or 12 less than last year. Twenty three were awarded the master's degree, the same number as last year.

Summer Practice Courses.—Over one hundred students in the College enrolled for summer practice courses during the summer of 1923. These courses have not only served the purpose in certain instances of acquainting the student with various phases of California's agriculture but in addition they have served to give the student considerable practice work which he cannot obtain during the regular semesters of the University. A few students during the summer of 1923 elected two summer practice courses in different lines of work.

Certain of the divisions, notably Animal Husbandry and Poultry Husbandry, have urged their students to substitute for the "99" courses, practical work. Students are relieved of the requirement of the "99" course for graduation by such substitution. They do not receive credit however for practical work taken outside of the University.

Changes in Graduation Requirements.—Two slight changes have been made in the graduation requirements during the past year. Heretofore 10½ units of Mathematics (including high school work) have been required for graduation. This requirement has been reduced to 9 units. A student may complete the mathematics requirement by three years of work in the high school. On account of the changes in the work required in high schools this change has been deemed advisable. Two of the following four subjects, Agricultural Chemistry, Bacteriology, Genetics and Soil Technology have been required for graduation in the past. On account of the increased importance of economics in relation to agriculture it has been added to the above courses. This permits the students to make their choice of two from five subjects including Economics 1A, 1B (one year).

New Work at Davis.—During the past year the Study Lists Committee, with the assistance of the divisions concerned, prepared a program of study for freshmen and sophomores at the Branch of the College of Agriculture. The work insofar as the requirements for graduation in the freshman and sophomore years are concerned duplicated that at Berkeley with the exception of Zoology and Agricultural Chemistry. Both of these subjects will be offered in 1923–24. The electives in technical agriculture at Davis now cover a wide range of subjects.

The freshman and sophomore work inaugurated at the University Farm has been markedly successful. The giving of fundamental courses in science at the University Farm has enabled students to transfer between Berkeley and Davis at will without loss of time. Students themselves are practically a unit in praising the opportunities offered to obtain courses in pure science and agriculture during the same

semester. This work is bound to result in the election by the students themselves of more fundamental work during their junior and senior years. The rearranging of courses is enabling students to further simplify their schedules. By far the larger percentage of senior students have been in residence at Berkeley. Members of all classes have been in residence at both Berkeley and Davis and the mingling of these different classes has been a decided advantage to both parts of the College. It would be a most serious mistake to return to the old ruling in force before last August whereby students were restricted to Berkeley or Davis during specific years. The greater part of the adverse criticism due to this lamentable condition of affairs has ceased.

The giving of this work has served a greater purpose in that it has further cemented the student body of the College of Agriculture. The awarding of scholarships and prizes to students within the College has further strengthened this already close tie of union. What seemed to be an experiment in the giving of work at both Davis and Berkeley has worked out to the satisfaction of all concerned.

Non-Degree Curriculum.—The non-degree curriculum has been made attractive to the person desirous of obtaining a short course in preparation for actual farming. The non-degree curriculum as now offered corresponds to the short courses offered by most of the agricultural colleges of this country. Plans are under way to still further concentrate this work. The number graduating from this curriculum in May, 1923, was 54. During the past year 169 students have entered this curriculum. The total attendance during the year has been 293.

A survey of the graduates of this curriculum has shown that over 75 per cent are engaged in some type of agricultural work.

By far the larger proportion of students in the non-degree curriculum obtain an eight months' course in some specialized agricultural work. The need for the former three-year Farm School Course has apparently ceased. A student may now obtain a certificate of graduation from this curriculum after two periods of eight months each.

The relationships existing between the Degree and Non-Degree students have been most cordial. The situation brought about by this contact has served to interest many of the non-degree students in work of collegiate grade. Several of the former non-degree students are now pursuing university work.

The College in its non-degree work has done, considering the cost and the results obtained, its most economical work.

Short Courses and Conferences.—The Short Courses and Conferences have enjoyed almost a 100 per cent increase in attendance.

Heretofore short courses have been held primarily for the novice in agriculture. These courses have largely been eliminated owing to lack of interest. The general agriculture course listed is the only course which has not been considered successful and it will be discontinued. It has been found that the producers already in agriculture are vitally interested in the results obtained by the research work of the College. It has also been found that short courses which are in reality conferences afford the best possible means of reaching the largest possible number of producers.

ANNUAL REPORT OF THE DIRECTOR OF AGRICULTURAL EXTENSION

By B. H. CROCHERON

It is ten years since the first farm advisor started to work in California. That event marked the beginning of organized agricultural extension work by means of agents of the College resident in the counties. It represented a definite and permanent extension of the College of Agriculture into the midst of the farms of the State.

In the report of the Dean of the College of Agriculture for the year ending June 30, 1913, it was noted (page 9) that a definite Division of Agricultural Extension had been created; that (page 17) the College had entered into coöperation with the U. S. Department of Agriculture with a view to organizing agricultural advisors throughout the State; and that (page 40) a coöperative agreement had been entered into by which an agricultural advisor had been placed in Humboldt County with headquarters at Eureka. At that time it was anticipated Congress would soon pass a bill distributing funds to the States to be expended by their colleges of agriculture for county extension agents.

By the date of the following report (June 30, 1914) the Smith-Lever Act had become a law, and it was announced (page 13) that "a system has been started creating the most direct method of bringing the man and the woman on the land in personal touch with the work of the Station." It was further reported that four farm advisors in all were appointed and that six additional counties had made the necessary appropriations and were awaiting the appointment of a farm advisor. The organization of the farm advisor system there described (page 14) is the same which since has been in continuous operation and which has led to the comprehensive service now organized. For historic interest, as well as present value, the principles there laid down may bear repetition. These were the following:

(1) "The University offers to appoint and pay the farm advisor only after the Board of Supervisors has appropriated $2,000 for the annual expenses of the advisor and there has been organized in the county a farm bureau of at least one-fifth of the farmers of the county with an annual membership fee of one dollar."

(2) "The farm advisor is required to serve any farmer in the county, whether a member of the farm bureau or not, but he is instructed not to visit any farm unless he is invited to do so."

(3) "The purpose of the farm bureau is, first, to demonstrate whether the farm advisor is really wanted by the farmers themselves, and, second, to create an efficient working agency."

(4) "The farm advisor does not seek to control or direct the action of any person. He gives to each person the best advice of which he is capable through the aid of the staff of the Agricultural Experiment Station, but the initiative still rests with the person seeking the advice. If, for the successful prosecution of the methods advised, it is necessary to have concerted action, or if it is necessary to pass and execute laws, the people must take the next necessary steps, or the legislative and executive branches of the Government must create and execute such measures as the investigations of the Station show to be warranted by the facts."

The above principles, then unique, have since received common acceptance, if not adoption, among the States. In the belief of the writer, these principles as executed during the past decade are responsible in large measure for the permanent maintenance of county extension agents by all counties that have installed them in California and for the statement in the report of the Special Legislative Commission on Agricultural Education (page 52) that "as a result of our observations it would seem that the Agricultural Extension Service of the University of California is not surpassed by any other."

The present fiscal year also marks the maturity of the Smith-Lever Act which became a law on May 8, 1914. It will be recalled that after the initial appropriation of $10,000 per State made for the first year, the appropriation under this act was to be increased by a half-million dollars per year for eight years. These sums were to be apportioned among the States according to their rural population, provided the States appropriated equal amounts and provided further that all the money was expended for certain specific types of extension work under projects approved by the Secretary of Agriculture of the United States. It was evidently anticipated that when the act reached maturity in the fiscal year 1922-1923 sufficient funds would be available to place an agent in every agricultural county in the United States. Despite supplementary appropriations by the States and the Federal Government, the increased costs that have maintained since the war together with additional types of service since developed have made the act insufficient to meet its original purpose in full. Of the 3,044 counties in the United States

reporting agricultural products, the United States Department of Agriculture states there were 2,104 counties which had men county extension agents on July 1, 1922. In addition there were 801 women county extension agents, and 205 boys and girls club agents.

In California, due to the generous support given to agricultural extension work by the people of the State, it has been possible to realize the original intent of the work. It was early expected that about forty counties would be the probable limit of growth under the Smith-Lever Act and that in these counties there might be organized about six hundred community centers. This early forecast was repeated in print in September 1916 (Journal of Agriculture, page 8) wherein it was stated: "There are in California 175 farm bureau centers established in fourteen counties . . . . The movement is spreading so rapidly in California and has witnessed such steady progress that it is possible to predict that by 1922 there will be 600 farm bureau centers in forty counties throughout the State." Since the original prediction was made, a war and its attendant circumstances have intervened, but the work has gone forward about as mapped out and as predicted. In December 1922 there were 544 active farm bureau centers in the forty counties of California in which farm advisors were established.

Other agencies for additional service have been organized during the intervening years. The report of June 30, 1914, mentioned that "through the enthusiastic action of the agricultural club of this College, acting in coöperation with the Extension Division, agricultural clubs have been established in 84 high schools of the State." The agricultural clubs thus started have now become a considerable enterprise.

The annual report of the President of the University for 1918 (Supplement, page 69) announced the establishment of home demonstration agents each for a district consisting of a group of counties. This method being found ineffective, county home demonstration agents were established as stated in Circular 208, issued in February 1919 (page 13). In that place the following venturesome statement was made: "There is no doubt that the work with farm women will, in the forthcoming years, reach as large a field of usefulness as that occupied by the departments especially designed for men." This prediction has since become an assured fact in the twenty-one counties in which home demonstration agents are established.

Assistant farm advisors early became necessary in many counties. Three itinerant assistants were first appointed in 1915. There were five of them at the outbreak of the war in 1917. Growing demands and new responsibilities made necessary the intensification of the

system. A general plan was devised which offered one farm advisor or assistant to every 1,500 farmers in the county. Thirty-three assistant farm advisors are now employed. Demands from the counties for additional assistant farm advisors continue in excess of the number made possible by available funds.

Agricultural extension specialists, who are trained men in charge of special extension campaigns or projects, are a recent development, too new to require recapitulation. In 1917 a Poultry Extension Specialist, the first of such a group, was employed. His success has led to the present development along that line.

The dates on which county extension agents were installed in the counties, given in order of their installation, were as follows:

County	Date Farm Advisor installed	Date Asst. Farm Advisor (if any) installed	Date Home Demonstration Agent (if any) installed
Humboldt	July 1913	....	....
San Diego	Mar. 1914	Sept. 1917	Jan. 1919
San Joaquin	May 1914	Nov. 1917	Jan. 1919
Yolo	June 1914	....	Aug. 1922
Napa	Sept. 1914	Sept. 1917	....
Madera	Sept. 1914	....	Oct. 1922
Alameda	Sept. 1914	Oct. 1917	Oct. 1918
Kern	Sept. 1914	Nov. 1917	Dec. 1918
Glenn	Mar. 1915	....	Aug. 1922
Solano	Mar. 1915	....	Nov. 1921
Stanislaus	Aug. 1915	Sept. 1917	Oct. 1921
Placer	Aug. 1915	....	....
Imperial	July 1916	Nov. 1917	Oct. 1918
Sacramento	Jan. 1917	Nov. 1917	Aug. 1920
Merced	May 1917	Sept. 1917	Jan. 1920
Nevada	May 1917	....	....
Riverside	May 1917	May 1918	Oct. 1918
Fresno	July 1917	Oct. 1917	....
San Bernardino	Sept. 1917	Feb. 1920	Oct. 1918
Contra Costa	Dec. 1917	....	Oct. 1921
Los Angeles	Dec. 1917	Jan. 1918	....
Santa Cruz	Dec. 1917	Aug. 1919	Nov. 1921
Shasta	Dec. 1917	....	Oct. 1918
Tulare	Dec. 1917	June 1918	....
El Dorado	Jan. 1918	....	....
Kings	Jan. 1918	Oct. 1921	Sept. 1920
Mendocino	Jan. 1918	Oct. 1922	....
Sonoma	Jan. 1918	July 1920	....
Ventura	Jan. 1918	....	....
Orange	Mar. 1918	Sept. 1920	....
Sutter	Mar. 1918	Aug. 1922	....
Monterey	April 1918	June 1920	Aug. 1922
Yuba	June 1918	....	....
Butte	Aug. 1918	Nov. 1920	Aug. 1922
Tehama	Aug. 1918	....	Nov. 1921
Santa Barbara	Aug. 1920	....	....
Marin	Sept. 1920	....	....
San Benito	Sept. 1921	....	....
Inyo	Oct. 1921	....	....
Lassen	April 1922	....	....
San Luis Obispo	Dec. 1922	....	....

The Agricultural Extension Service now comprises 125 full-time appointees on the regular staff in addition to certain part-time appointees and the clerical staff. The full-time positions created on the regular staff are as follows:

Farm Advisor Project:
- 41 County Farm Advisors.
- 33 Assistant Farm Advisors.
- 3 Assistant State Leaders.

Home Demonstration Project:
- 21 County Home Demonstration Agents.
- 3 Home Economics Specialists (Clothing, Home Furnishing, Nutrition).
- 2 Assistant State Leaders.
- 1 State Leader.

Boys' and Girls' Agricultural Club Project:
- 3 County Club Leaders.
- 3 Assistant State Leaders.

Agricultural Extension Specialist Project:
- 9 Agricultural Extension Specialists (Dairying, Citriculture, 2 Poultry, Irrigation, Agricultural Engineering, Farm Management, Walnut Growing, Illustrative Materials).
- 1 Assistant State Leader.

Administration and Public Service Project:
- 4 Specialists (2 Public Service, 2 unorganized counties).
- 1 Director of Agricultural Extension.

Heretofore it has not been customary to present in detail printed annual reports of the work of the Agricultural Extension Service because of the cost involved in printing such reports, which are necessarily voluminous. Manuscript reports in detail for all phases of extension work during the past ten years are on file in the State Extension Office, in the office of the Dean of the College of Agriculture, and in the Office of Extension Work of the United States Department of Agriculture. Because of the decennial of organized extension work this year, there is given a resumé of the work of the past year which is presented in place of the brief summary hitherto customary. It is believed that this may be warranted, not only in view of its wide immediate interest, but also for later historic review. The statistics given are necessarily for the crop year 1922.

WORK OF THE YEAR 1922–1923 IN AGRICULTURAL EXTENSION

General Activities.—The Agricultural Extension Service has attempted to keep clearly in mind that in its various analyses and reports it must seek more than a mere compilation of its multiplicity of activities. These are only a means toward the end which it is designed to reach, namely, the betterment of rural conditions in California.

Many organizations confuse the respective values of activities and results. Any large enterprise must carry on a wide range of activities, the very volume of which is impressive. This, however, does not prove that the enterprise has any real usefulness nor that an increase or decrease in its activities has any definite relation to its value to the public. This report, therefore, will mention but briefly the general activities of the year and will be given over chiefly to a discussion of the results of the work as related to specific commodities and to the interests of rural life in California.

When activities involve the voluntary coöperation of the public their increase or decrease does have some relation to the public estimate of the work. The many thousands of persons who continue to call upon the farm advisors and home demonstration agents for advice, the thousands of meetings before which these agents are annually asked to speak with an attendance aggregating hundreds of thousands, and the great multitude who ask the agents to call at their farms to help solve local problems:—these all indicate an appreciation of the services of the county extension agents which must be based upon the results previously secured. In the early years of the work it was sometimes said that perhaps persons sent for the farm advisors to "see what they would say" or that people came to their meetings out of curiosity. This could hardly be the correct explanation after a period of ten years of continuous service. Their popularity is quite evidently based upon an appreciation of their value and helpfulness in meeting problems of the farms and farm homes. There are here set forth, therefore, some of the statistical tables itemizing the activities of county extension agents. From these there may be gained some estimate of the great fields of activity which the agents occupy and the popular respect in which they are held, a respect which is based upon their usefulness in improving rural life.

During the year 1922 the farm advisors made upon request 33,476 farm visits at 16,635 farms. The home demonstration agents visited 2,382 farm homes. There were 58,079 persons who called at the

farm advisors' offices for advice and 4,840 who called on the home demonstration agents. The farm advisors held 11,465 meetings of all kinds during the year, attented by 424,556 persons. The home demonstration agents held 4,896 meetings attended by 70,727. The farm advisors wrote 61,781 individual letters; the home demonstration agents wrote 9,519 letters. The agents sent out 2,263 circular letters, the total circulation of which was 218,704.

The comparative growth of some of these activities is shown by the tables herewith presented, which give comparable statistics for the farm advisors since 1914 and for the home demonstration agents since 1918. It may be noted that there was a slight decline in volume in some of the statistics for the farm advisors in 1922. It is believed that this was caused by the greater stress laid upon the accurate measurement of farm demonstrations. These consumed so great a proportion of time that less than normal was left for other miscellaneous work. The difference is reflected in the relatively large increase in the number of farm visits made during the past year.

STATISTICS FOR FARM ADVISORS

	1915	1916	1917	1918	1919	1920	1921	1922
Farm visits made	9,106	8,822	13,169	26,492	25,116	26,689	27,703	33,476
Meetings attended	1,585	1,834	5,049	5,420	5,479	8,184	10,511	9,300
Attendance at above meetings	64,144	89,576	103,792	205,662	206,475	323,266	427,690	346,075
Farm demonstrations located	707	685	756	1,420	3,363	1,926	3,946	3,919
Field demonstration meetings held	193	189	349	870	1,171	1,255	1,908	1,832
Attendance at demonstration meetings	5,187	5,991	15,735	22,354	47,372	49,845	80,351	60,390
Office calls for agricultural advice	1,278	9,762	22,864	50,261	47,306	57,062	60,461	58,079

STATISTICS FOR HOME DEMONSTRATION AGENTS

	1919	1920	1921	1922
Home made visits	1,653	1,634	1,521	2,382
Meetings attended	1,451	1,704	2,136	4,896
Attendance at meetings	38,887	44,624	50,171	70,727
Talks and demonstrations given	1,451	1,669	1,507	3,175
Attendance at above	38,887	44,143	43,411	52,171
Office calls for advice	2,433	3,842	4,340	4,840

Development of Demonstrations.—"A demonstration is an effort designed to show by example the practical application of an established fact. Demonstrations may be of methods or of results." The above definition has stood for many years to designate

the type of work for which the Agricultural Extension Service was primarily designed. During recent years an attempt has been made to increase the relative proportion of "demonstrations of results." The "demonstration of methods" is one at which mechanical processes are demonstrated by visual example, but the beneficial results of the processes are not always evident at the time the demonstration is given,—often the results have to be taken on faith. For example, a "demonstration of methods" would be one at which a pruning demonstration was given before a group of persons where one or

Fig. 122.—A field meeting on the thinning of deciduous fruits, held in the spring of 1923. The farm advisors held 1832 field meetings during the year 1922, attended by 60,390 persons.

more trees were pruned according to the method advocated by the demonstrator. He could state that the method was superior, but his only actual evidence would be statements of results achieved elsewhere. A "demonstration of results" is one in which definite plots or other groups of individual elements are treated by the method advocated, where at the end of a period of time the accrued results mature and are contrasted with the usual or local method. A demonstration of results with regard to pruning would require the layout of plots illustrating one or more methods of pruning and the observation of the resultant yield of fruit at the end of one or more seasons. The demonstration of results is more convincing because

Fig. 123.—Signs are used to attract attention to demonstrations of results located throughout the counties. Three thousand five hundred and fourteen such demonstrations of results were active during the year.

Fig. 124.—A meeting of the Santa Cruz County Board of Directors of the farm bureau, in general session with the local chairmen of farm home department of that organization. The farm home departments are an integral part of the county farm bureaus. Men and women together work out plans for the improvement of rural conditions.

it carries the demonstration further, leaving less to the faith and imagination of those attending. It remains as a visable evidence of contrasted methods and by all standards of pedagogic procedure is superior to a mere demonstration of methods. It requires, however, more time on the part of the demonstrator, and, because of the time element necessary for its maturity, is more likely to be destroyed by neglect or natural hazards. It is believed to be so valuable, however, that every effort should be made to increase the proportion of demonstrations of results, even though it is realized that this will mean a lessening in the actual number of demonstrations given and possibly in the variety of activities that can be undertaken in any one year.

There follows, arranged according to subjects, a tabulation of the "demonstrations of results" that were active during 1922. This shows the percentage of accomplishment and the mortality of these up to December 1, 1922. In considering this table it must be remembered that it does not include the large number of "demonstrations of method" conducted during the year.

Demonstrations of Results Active in 1922

Farm Advisor Work

Subject	Demonstrations continued from 1921	Demonstrations started 1922	Demonstrations active 1922	Results secured	Results lost	On which results will not mature till 1923
In soil improvement (general)	39	59	98	37	33	28
Irrigation	1	1	2	2	0	0
Drainage	8	21	29	9	4	16
Alkali	0	1	1	1	0	0
Cover crops	104	146	250	135	52	65
Commercial fertilizers	42	129	171	98	51	22
On field crops	13	179	192	109	21	62
On fruits and vines	1	118	119	13	0	106
Lime	26	31	57	24	14	19
Gypsum	5	2	7	2	3	3
Subsoiling and blasting	23	16	39	30	5	4
Soil inoculation	2	2	4	0	4	0
In crop production (general)	4	7	11	4	6	1
Field crops (general)	2	10	12	7	5	0
Cereals (general)	32	107	139	87	45	7
Wheat	5	17	22	18	4	0
Barley	10	33	43	35	8	0
Beans	0	2	2	0	2	0
Potatoes	0	25	25	19	3	3
Potato clubs	0	1	1	1	0	0
Alfalfa	3	11	14	13	0	1
Grain sorghums	0	168	168	114	54	0
Grain sorghum clubs	0	3	3	3	0	0
Forage crops	102	206	308	180	91	37
Cotton	0	4	4	2	0	2
Sugar beets	1	2	3	1	1	1

Subject	Demonstrations continued from 1921	Demonstrations started 1922	Demonstrations active 1922	Results secured	Results lost	On which results will not mature till 1923
Vegetable growing	0	8	8	0	0	8
Mixed vegetable clubs	0	1	1	1	0	0
Small fruit growing	1	1	2	1	0	1
Seed improvement (general)	1	36	37	0	0	37
Seed production and marketing	10	17	27	22	2	3
Orchard and vineyard crops (general)	0	0	0	0	0	0
Orchard planting	0	6	6	5	0	1
General orchard management	12	69	81	22	2	57
Grafting and budding	27	8	35	20	14	1
Tree wiring	1	24	25	25	0	0
Tree surgery and rejuvenation	14	30	44	31	7	6
Orchard pruning (general)	27	26	53	37	12	4
Deciduous long-pruning	80	142	222	102	39	81
Citrus pruning	17	5	22	3	9	10
Vineyard planting	0	2	2	2	0	0
General vineyard management	0	39	39	8	0	31
Demonstration vineyards	4	11	15	14	1	0
Vine pruning	12	10	22	18	1	3
Rodent and pest control	7	62	69	50	8	11
Rodent control	0	2	2	1	0	1
Smut control	60	61	121	68	23	30
Orchard pests (general)	46	118	164	124	8	32
Apiculture	0	3	3	0	0	3
In livestock production (general)	0	0	0	0	0	0
Dairy improvement	12	19	31	19	10	2
Cow-testing	57	109	166	66	3	97
Better sires	24	35	59	20	4	35
Better feeding	56	29	85	28	56	1
Silos	14	29	43	38	5	0
Balanced rations	56	0	56	0	56	0
Dairy calf clubs	2	7	9	9	0	0
Beef cattle improvement	0	7	7	7	0	0
Range improvement	3	16	19	4	3	12
Swine improvement (general)	0	1	1	0	0	1
Better feeding	0	3	3	2	1	0
Hog auction sales and other marketing	0	2	2	2	0	0
Hog feeding clubs	4	19	23	18	5	0
Sow and litter clubs	1	0	1	1	0	0
Poultry improvement (general)	22	4	26	26	0	0
Poultry housing	1	0	1	1	0	0
Poultry feeding	10	10	20	10	0	10
Poultry culling	12	141	153	108	26	19
Flock inspection and certification	38	0	38	21	0	17
Coccidiosis control	0	9	0	9	0	0
Poultry clubs	0	25	25	25	0	0
Livestock disease control	0	1	1	1	0	0
In farm economics (general)						
Farm Accounts	0	10	10	4	0	6
In marketing (buying and selling)	0	1	1	0	0	1
Total	1054	2460	3514	1917	703	894

Community Program of Work.—It has been the longstanding policy of the Extension Service in California to encourage the farm bureau centers to develop a program of work based upon an analysis by each center of the needs of the community and the possibility of solving these difficulties through the medium of the local organization. These community programs of work may not be identical with the Extension Service program for that community. The people are encouraged to select their own program and in this the Extension Service will assist in so far as that program lies within its proper sphere and in so far as it has available assistance to render.

During 1921 there were 348 farm bureau centers which selected such a program of work. In 1922 the number had increased to 383. The projects adopted for the year 1922 may be grouped into the following general subjects. The totals include certain projects which were adopted in 1920 or 1921 but were as yet unfinished and were therefore included again in the 1922 program.

COMMUNITY PROGRAM OF WORK

	1921	1922
Soils, Fertilizers and Cover Crops	91	177
Irrigation and Drainage	59	93
Field Crops	59	177
Horticulture	195	312
Pests (Insects, Rodents, Plant Diseases, Weeds, etc.)	138	184
Animal Husbandry (Dairying, Veterinary Science, etc.)	109	282
Marketing and Purchasing	90	76
Home Improvement	30	323
Schools	77	82
Community Improvement (Roads, Telephones, Power, etc.)	385	353
Membership and Promotion of Subsidiary Organizations	182	233
Boys' Clubs	69	98
Farm Management	17	46
Legislation	16	19
Fairs	....	31
	1517	2536

County Program Development.—The development of a permanent program for agricultural extension work in the counties has received a large share of the attention of the supervisional force during the past year. There were 263 visits to counties made by supervisors on this subject.

The determination of a county program of work is a matter of gradual growth. It is not possible for the counties to be reached on all phases of agricultural development in any one year. An analysis of the situation during the past year disclosed the fact that in 15 counties it seemed probable that the more evident needs of the counties were met by the agricultural extension program then in

operation, while in 26 other counties the program did not seem to be entirely satisfactory. In 25 counties work of the farm home has been well provided for, and in 30 counties work with boys and girls was included in the program. In 28 counties it was found that the community programs of work were being followed consistently, and in 30 counties the farm advisor reported that these programs were more largely developed along agricultural extension lines than in previous years.

Fig. 125.—The county extension agents plan their work for the year in advance. These plans are charted on a calendar in the county office. All projects are so organized as to permit the work to go forward without conflict or confusion. The San Diego County farm advisor explaining the program to a farm bureau group.

All county extension agents use a calendar form for arranging projects on a program of work for the year; that is, not only are the projects laid out in regular written form with definite goals, but the work, month by month, on each subject, is shown on an office calendar or chart which gives space for record of the work actually done, as well as that projected. By this means the supervisional force can check up on their visits the progress that has been made in each county on the work in hand. Likewise, the supervisional

officer has a copy of this program for each project in his notebook and makes notes on each visit of the state of work on each project. It is evident that a large number of the projects under way in the counties will require several years for their completion, and that the matter of program development is largely predetermined at the beginning of each year by the program in force during the previous year.

Office Organization, Records and Reports.—An annual office survey was made in January 1920, 1921, 1922 and 1923. These office surveys included a written report upon the very extensive investigation of each county office. They are made by the assistant state leaders in the presence of the farm advisor himself. These surveys show a progressive improvement in the offices throughout the State.

Maintenance and Training of Personnel.—In general the maintenance of the personnel of the Extension Staff has been satisfactory. The following table shows the number and percentage of resignations since 1913:

Year	*Positions*	*Resignations*	*Per Cent*
1913–1914	9	0	0
1914–1915	16	2	13
1915–1916	26	2	8
1916–1917	35	1	3
1917–1918	83	5	6
1918–1919	91	31	34
1919–1920	91	17	19
1920–1921	93	11	12
1921–1922	109	10	9
1922–1923	125	11	9

One of the new developments during the past two years has been an undergraduate course in agricultural extension methods given in the College of Agriculture by Professor F. L. Griffin of the Division of Agricultural Education. This course was given during the second semester of the year 1921–1922 to a class of over thirty students. Four of these are now employed as assistant farm advisors in the Extension Service in California. The course considers the history of extension work and the methods of extension organization and administration. It has been found that the men who took this course are more advanced in extension work than other men of similar age and training graduating from the same college who did not take a course in extension methods. The course was repeated during the first semester of the college year 1922–1923.

Only one general extension conference was held during the past year which was in January 1923. Previously two such annual conferences had been held. It was felt, however, that the permanency

of the present force made it unnecessary to hold such frequent conferences. For the second time the annual conference spent a considerable portion of its time in committee work along various lines of agricultural interests. Seven committees of farm advisors were active, namely, on soil improvement, field crops, deciduous fruits and vines, citrus and tropical fruits, dairy, swine and poultry, beef cattle and sheep, and on farm economics. Every member of the farm advisor staff was on some one of these committees and with them members of the research divisions of the College of Agriculture were invited to meet. On the third day the committees reported to the

Fig. 126.—The assistant state leaders of farm advisor work are also active in the promotion of definite projects, in which they act as specialists in agricultural subject matter.

general conference. The home demonstration agents met in a separate conference during the time that these conferences were active. Their committee reports constitute a voluminous document.

Publicity.—The Agricultural Extension Service has not greatly stressed nor felt the need of State-wide publicity for the work accomplished. In general, the effort has been to use local means for publicity regarding local results, and to avoid the usual propaganda carried on by so many public agencies for the furtherance of their work. All but two of the farm advisors, however, regularly submit news notes to local newspapers. There are 31 counties which regularly publish the county farm bureau monthly, in which extension news is given. Only 10 counties do not publish such a monthly magazine. Unfortunately, many of these Farm

Bureau monthlies are published through an individual who may compile most of the material in them. Only 13 counties have editorial committees from the farm bureau to supervise material given in their publications.

The use of circular letters appears to be a matter on which there is no general conclusion. Fifteen farm advisors believe that good is achieved by the use of circular letters for widespread publicity of results in the counties. Eighteen farm advisors believe circular letters are a poor means of reaching the counties. Only 12 counties of the State use circular letters to any considerable extent.

The entire question of publicity is not generally understood throughout the counties. A large number of farmers feel that both the Farm Bureau and the Agricultural Extension Service would greatly benefit by more publicity. Indeed, they feel that propaganda is one of the strong forces making for success, and that it is the lack of such propaganda which has prevented the Farm Bureau from including in its membership practically all the farmers in any county.

In general, the Extension Service has not had such a point of view. Its policy has been that results accomplished in any county or community were sufficient to interest people in the work and to convince them of its efficacy if the results were of a character making in a large degree for the public good. The Agricultural Extension Service in California has come forward with apparent success, despite the fact that it has had no publicity agency and made no serious attempt to acquaint the general public with its work. There is undoubtedly, however, a field for a real news service which would be quite different from publicity or propaganda agencies, and which would wholly serve as an educational means of spreading the results of the research work, and thus supplement the demonstrational work done by the county extension agents. It has been noted, however, that the publication in most states known as "The Extension Service News" is more largely in the nature of propaganda than of an informational service. It is difficult in general to prevent house-organs of this character from becoming vehicles which attempt to convince of the value of the service, rather than maintaining their proper sphere, which is to act as a vehicle to convey information to the people of the State.

Development of Farm Bureau Departments Participating in Extension Work. *Farm Home Departments.*—Home demonstration work is carried on in coöperation with the farm home department of the farm bureau. This department is made up of

Fig. 127.—Members of the Agricultural Extension Service at their annual conference held at Berkeley in January, [illegible].
There are 135 persons on the regular staff.

all members of the county farm bureau who register in the department to work toward the solution of farm home problems. In each farm center where there are registrants in the farm home department, an executive committee of three is chosen from among the members. A program of work, based on the needs of the farm homes, is chosen and carried on by (1) exchange of information at meetings, (2) application of information in the home. Meetings in each center are held usually once a month with the home demonstration agent, and at other times as needed with the project leaders.

One of the center executive committee is designated center chairman. These (averaging about thirteen in a county) compose a county farm home department committee, which meets usually once a month to hear reports of work accomplished in the various centers, and to plan the further carrying out of projects. These chairmen choose three from their number to be a county executive committee. The chairman of this committee is *ex-officio* a member of the County Farm Bureau Board of Directors.

Twenty-one counties have a farm home department, working with a resident home demonstration agent. Nine additional counties have organized a farm home department to carry on projects concerned with the farm home, and to work toward securing a county home demonstration agent. In 1922, the 21 counties with a home demonstration agent had 239 farm home department centers with a registration of 5667.

Aside from the farm home department, of the various farm bureau departments existing in California dairy departments, poultry departments with their various subdivisions and horticultural departments are the most prevalent.

Poultry Departments.—Santa Cruz, Sonoma and Los Angeles counties have egg-laying contests under the farm bureau poultry department. In these counties there are about 160 entries with twelve birds per entry. Sonoma County has in addition an accredited hatchery under the farm bureau department with a capacity of 1,500,000 eggs per filling. Sonoma County has also a Poultry Registry Association which comes under the poultry department of the farm bureau. During the past year over 2000 birds were registered. In Los Angeles County, aside from the egg-laying contest under the poultry department of the farm bureau, a feeding test is being conducted. During the past year the tests have been on milk products in various combinations, about 300 birds being used in the experiments. In Alameda County a flock inspection and certification has been carried on under the poultry department of the farm

bureau. About 50,000 breeders were inspected and culls removed. Santa Cruz County has under the poultry department of the farm bureau not only the egg-laying contest but an agency for the distribution of eggs or day-old chicks from selected stock to boys' and girls' agricultural clubs throughout the State. Tulare County Poultry Department of the farm bureau in coöperation with the Poultry Association and local organizations held a cockerel auction sale, selling only those birds known to have come from high quality hens.

Dairy Departments of the farm bureau have been active during the past year; especially in developing cow-testing associations in Humboldt, Imperial, Kings, Los Angeles, Orange, San Diego, San Joaquin, and Sonoma counties.

The Los Angeles County Farm Bureau has besides the Poultry and Dairy Departments a Citrus Growers' Department, a Deciduous Fruit Growers' Department, a Potato Growers' Department, and a Walnut Growers' Department. These departments have been thoroughly organized during the year. Imperial County Farm Bureau has organized a Grape Growers' Department which hopes to aid the growers on problems of production and disposal.

In Shasta County a Beekeepers' Department has been a large factor in raising the standard of beekeeping practices in the county. Pure-bred queens are now being used in every apiary of any size. The Dairy Department has helped to raise the standard of the dairy herds by placing six pure-bred bulls in grade herds and by bringing into the county during the year 63 good grade cows. The Cattlemens' Department has started a range improvement project with five test plots to find out the effect of protection to the range on overstocked areas.

Sonoma County has a Junior Department of the farm bureau functioning in three schools with a probable addition of two more within a few months. A tentative program of work has been adopted covering the four major projects of (*a*) Stock Judging Contest, (*b*) County and State Fair Exhibits, (*c*) Junior Center Basket Ball Contests, (*d*) Visiting Day Competition. A Junior Department was organized in Monterey County in October.

The Purple Vetch Seed Growers' Department of the Humboldt County Farm Bureau has continued its activities. During the 1922 season over 2400 acres of vetch were planted, 200 tons of seed harvested with an actual value of $261,000.

A tabulation of the farm bureau departments in California shows that in November 1922, 35 county farm bureaus had a total of 91 organized departments. Of these 23 were farm home departments,

19 dairy departments; 9 deciduous fruit growers' departments; 8 poultry departments; 4 marketing departments; 3 departments each for beekeepers, citrus growers, grape growers, live stock, walnut growers, and junior department of the farm bureau; while there was one department each organized for club work, fire protection, grain growers' exchange, irrigation, potato growers, purple vetch seed growers, road and bridge, and wool growers.

Development of Project Leaders.—The farm advisors in California are unanimous in reporting that the development of volunteer project leaders is difficult and unsuccessful unless the

Fig. 128.—A project leader conducting a demonstration in Stanislaus County. Volunteer project leaders are active in many counties. Meetings are called at which these project leaders, representing the various farm centers, come together to confer on the subject matter which they in turn are to present in their local communities.

leader is selected with care both as to his capacity for leadership and his interest in the project. The increase of the farm bureau departments is developing men who are being selected as project leaders with great success in some of the counties. The women in farm home departments are developing more rapidly as project leaders than the men in other departments, but many of those who are carrying demonstration plots are gradually coming to be leaders in their communities and thus are selected, if possible, for project leaders. The indications are that within the next few years a much stronger group of leaders will be found in this State due to (1) to the development of the farm bureau departments, (2) to the gradually increasing number of those who are acting as demonstrators, and

(3) to a better knowledge of what is required of a project leader and hence a more careful selection both of the leader and of the committee working with him.

DEVELOPMENT OF PRODUCTION CONTESTS.—Production contests are developing chiefly along the lines of (1) fruit, (2) eggs, (3) pork, (4) butter fat.

(1) *Fruit Growing.*—Peach Growers' Contest. This Contest first developed in Sutter County in 1920 was continued in 1922 with additional plots from Butte County.

Year	*Plots in contest*	*Plots completing*
1920	82	55
1921	102	65
1922	111	69

Due to extension and farm bureau activities the percentage of increase in growers using cover crops and fertilizers is very marked.

Contestants planting cover crops		*Contestants using fertilizers*	
1920	11%	1920	1.8%
1921	29%	1921	4.4%
1922	45%	1922	14.5%

In 1922 the prize-winning orchard produced 24½ tons No. 1 fruit per acre, and one three year orchard 6⅖ tons per acre. Prizes were awarded on a basis of 100 points, five points being given for the care shown cultural operations, fifteen points for the condition of the orchard after the fruit had been removed and eighty points for the tonnage of No. 1 fruit. The orchards entered were divided into fifteen classes according to the varieties and ages of the trees. The Sutter County farm advisor makes this comment upon the contest: "It has been discovered that the contest improves the agriculture of the community by calling attention to the prize-winning orchards and the possibilities of production. One big factor of the contest is that it enables the fruit growers to come together and organize for mutual benefit. Out of the Peach Growers' Department of Sutter County the California Canning Peach Growers originated; this is now a State-wide organization." Stanislaus County had 68 entries in the Canning and Dried Peach Contest, representing about 500 acres. Tehama County had 23 entries in a Peach Growers' Contest of which 17 were completed. A Gravenstein Apple Growers' Contest was started in Sonoma County with 50 plots entered, divided into six classes. At the end of the season prizes were awarded according to the class. After several years continuation this project should show results in the better methods of orchard management.

(2) *Egg Production.*—Three counties, Santa Cruz, Sonoma and Los Angeles, have had egg-laying contests. Santa Cruz County in its third year of work had 63 entries. Sonoma County had 48 entries on its second year contest, while Los Angeles County completed its first year contest on September 30, 1922, with 48 entries. These contests have stimulated great interest both within and without the counties where they are being held. The poultrymen of southern California have become interested to the extent that the Poultrymens' Department of the Seven Southern Counties of the California Farm Bureau Federation have adopted the Southern California Farm Bureau Egg-Laying Contest as one of their projects. One county, Shasta, is carrying on a Farm Flock Production Contest, a cash prize to be awarded to the person making the highest average in twelve months.

(3) *Pork Production.*—Contests in production of pork to be shown and sold on a specially designated Pork Day were not as numerous or as successful as during previous years. In California, hog raising has been chiefly an adjunct to dairy farming. A gradual change of practice on the part of creameries, whereby they take the entire milk instead of merely the butter fat, is resulting in a lack of skim milk for feeding hogs; consequently fewer hogs are being raised and the interest is not as keen.

In Shasta County four carloads of hogs were fed and entered in the Pork Day contest. Prizes were awarded ranging from $100 to $35 for the best carload lot; $25 to $10 for the best pen of ten hogs; $7.50 to $3 for the best individual hog. These hogs, sold at auction, brought from 1 to 1¼ cents per pound higher than the local prices. Stanislaus County had 45 entries, with a total number of 499 hogs. The farm advisor in Merced County reports: "Pork Day on the whole proved successful although there were 250 hogs less than had been signed up. From an educational standpoint the effort was not worth while. The hogs were of exceptional quality, both from a breeding and feeding standard, due, undoubtedly, to former work of the Extension Service in hog auction sales and other pork production work." The Swine Growers' Department of the Fresno County Farm Bureau organized in December, 1921, a hog production contest to demonstrate by feeding and judging the best type of hog for meat production. The committee did excellent work resulting in fourteen carloads of hogs being auctioned on Pork Day, October 20, 1922. Two criticisms are offered: (1) giving of cash premiums in amounts so large that the exhibitors lost sight of the educational value of the show and entered purely on a commercial basis: (2) not allow-

ing the judge sufficient time for giving reasons and explanations so as to secure the greatest amount of educational value.

(4) *Butter Fat Competition.*—The Los Angeles County Farm Bureau Dairy Cow Competition conducted by the Dairymens' Department of the farm bureau was started on its third year July 1, 1922. This dairy cow competition was started originally to increase interest in the cow-testing association and to create a friendly rivalry among the dairymen to urge better and more efficient work in the production of milk. The results of the past two years and the interest shown during the third year indicates that the competition has developed along the lines planned. When the cow-testing association started in May, 1918, there were approximately 3000 cows included. At the present time there are about 6200 cows under test. This increase cannot be attributed entirely to the competition,—yet the competition has served to get dairymen together at meetings, to secure wider use of better sires and to discuss better feeds and care.

Some marked increases in the average production of herds are shown in the annual reports.

POUNDS OF BUTTERFAT

Herd	*1920*	*1921*	*1922*
A	320.5	366.5	453.2
B	304	320	350.4
C	275.4	330.5	366.7
D	......	300	347.3
E	......	371.2	414.4

The cost of testing ranged from 15 to 21 cents per test per month, or an average of $1.70 per cow per year. One dairyman has been able to increase his income during the past year by $78.03 per cow. Summarizing the data for the year, the average for all herds in the association two years or more was 353.6 pounds of butter fat per cow, while the average for the herds in the association only during the past year was 312.2 pounds. This shows an average increase of 41.4 pounds of butter fat per cow in herds in the association only one year. This increase at 90 cents per pound amounts to $37.26.

Kings County has a small dairy cow production contest with fourteen dairymen and 700 cows signed up. Shasta County dairy cow production contests at two district fairs were of such educational value as to be forerunners of a cow testing association in the county.

DEVELOPMENT OF RECREATION AND OTHER SOCIAL CONTESTS.—It is very hard to get an accurate check upon all of the social activities held by county farm bureaus and farm bureau centers. There are, however, 29 counties that report on these activities. One hundred

twenty-nine farm bureau centers have committees on recreation and social development. Two counties report a county chairman for these functions—one is a county librarian and the other a recreational director of the county public schools. Assistance from schools and State normal schools was received by five counties. Twenty farm bureau center plays were given. Three farm bureau center plays were repeated at other centers in the county. One farm bureau center has raised $650 for road improvement purposes through plays. One Chamber of Commerce maintains an entertainment committee which gives evening programs at farm bureau center meetings. Christmas entertainments were given at eight farm bureau centers. Two counties report the use of moving pictures as very successful in entertainment. At nine farm bureau centers when the Spring Valley film was shown an attendance of 2000 was reported. Four community dinners were held. One county reports an attendance of 693 at fifteen 'phun-nites.' 'Phun-nites' were held in four other counties. Nine county picnics were held, one county reporting an attendance of 6000 at their county picnic. Baseball leagues were formed in three counties, ten teams playing at various times in the season.

Agricultural Club Encampments, Hikes, Etc.—Entertainment in the form of hikes, camps and parties play a very important part in the lives of agricultural club members. These camps and hikes are maintained as a means of creating interest among agricultural club members for the purpose of doing a more important demonstrational work in animals and field crops. Two very successful agricultural club camps are held each year in the State, one for the Fresno County Agricultural Club members at General Grant National Park, and the other at the Branch of the College of Agriculture at Davis.

The number of club members, including girls and boys, to enjoy the camp at General Grant National Park was 145. A much larger number, however, was present at the three-day camp held at the Branch College of Agriculture, inasmuch as the camp here represented agricultural club members from over all the State. Thirty-three counties were represented with a total of 483 persons. Eighteen counties were represented by 10 or more club members, four counties had 30 or more, and one county was represented by 46 members. The camp at the Branch College of Agriculture is held primarily as an honor camp for those agricultural club members who were winners in their county agricultural club contests. While at the convention the club members are taken care of much the same as in a military camp. Agricultural club leaders are placed in charge of companies and during the day the various companies attend dem-

onstrations held for their benefit on the farm at the Branch College of Agriculture. The evenings are devoted to stunts and fun in general, including indoor and out-of-door activities.

Some of the trips taken by other agricultural clubs were: a ten-day pack into the Kings River country, a one-week trip into the Yosemite Valley, and a three-day trip on the Sur River. These county and local hikes or camps are financed from various sources. Some of the clubs run small stores at their schools, selling 'hot-dogs' and eatables at lunch time; others have held box socials and plays. Two box socials and two picnics were reported this past year. Two counties

Fig. 129.—Fresno County conducts an annual camp for its club members in the General Grant National Park. In 1922, 145 were present.

held agricultural club field tours, the purpose of which was to observe the results of various club members. One hundred twenty-six achievement days were held for the purpose of reviewing the work done by agricultural clubs. Two county clubs held baseball schedules throughout the baseball season.

County and Community Fairs.—There were 29 county and community fairs in California during 1922. The farm advisors and home demonstration agents participated in 26. At ten of these 26 fairs, the advisors maintained booths depicting the work of agricultural extension in these counties. Three of the farm advisors report an attendance of 24,200 persons at three fairs.

Generally speaking, there are three types of fairs held in California counties: (1) fairs that are managed and promoted by private organizations; (2) fairs that are controlled and managed by a fair association or stock companies; (3) fairs conducted by committees of

Fig. 130.—An agricultural club convention is held at the University Farm at Davis each year. In 1922 there were 483 boys and girls in attendance.

the county farm bureaus. This last type is owned by the farm bureau members and the management is in the hands of a fair committee of the county farm bureau. The touch of personal interest and responsibility is felt in the last type in a way that may be entirely lacking in those fairs managed and conducted under other plans.

SOIL IMPROVEMENT

IRRIGATION.—While the active irrigation projects on file in the office of the Director of Agricultural Extension are only four in number, there was some activity in irrigation matters reported by

Fig. 131.—Farm bureau centers throughout the state generally hold meetings each month. They act as a center for rural improvement, including the various phases of social life in the open country. Five hundred and thirty four such centers are active in the state.

all farm advisors except nine. The counties from which no reports have been received are of two classes, those in which irrigation development work is just starting, and old irrigated communities whose practices are generally standardized.

Two of the projects on file in the office of the State leader were campaigns. One, in Napa County, was to demonstrate the value of irrigation in that county. This was accomplished by means of 25 personal visits, by assisting seven farmers to plan irrigation systems and by conducting a tour in which a group of sixteen farmers visited twelve irrigated farms. The project is being further carried on in 1923.

A campaign for better orchard practice in Los Angeles County resulted in the development of plans for the survey of orchard irrigation methods. Numerous borings were made which showed a general deficiency of water in most of the orchards. A new project is organized for 1923 in the Citrus Growers' Department of the Los Angeles County Farm Bureau. Some sixteen meetings with an attendance of 560 were held to investigate soil moisture conditions.

Two projects concerning irrigation were conducted in Imperial Valley. The first was a test of the comparative value of the corrugation method of irrigation as against flooding methods for barley. There was apparently a better yield of grain under the corrugation method, but the results of a single test could not be conclusive. The second project was a demonstration in the use of irrigation water, and apparently the people of one farm center found that the use of long borders gave better results in the application of water.

The activities of the various county farm advisors are summed up in the following summary:

IRRIGATION ACTIVITIES BY FARM ADVISORS

Soil moisture meetings *No.*	*Soil moisture meetings* *Attendance*	*Assisted in planning Irrigation systems*	*Tours* *No.*	*Tours* *Attendance*
30	936	37	2	52

In addition to the above activities there were numerous personal visits and discussions at farm center meetings.

Five counties have new irrigation districts under consideration. The farm advisors in these counties keep in close contact with such movements and generally assist by advice in organization work. In Shasta County an irrigation department of the farm bureau has been formed. It is composed of the five farm bureau centers within the Anderson-Cottonwood Irrigation District.

Orange County reports that an effort will be made to secure a schedule of water delivery that will enable orchardists to apply water in accordance with the recommendations of the Extension Service.

In Contra Costa County the farm advisor with assistance from the University staff recommended certain fruit as adaptable for the conditions in Lone Tree Irrigation District.

Nevada County reports that the cost of water is holding back development in that section.

In Santa Cruz County the engineers of the Bureau of Public Roads, United States Department of Agriculture, have reported on an irrigation project costing in the neighborhood of $170,000. Further investigations of this project will be made in 1923.

DRAINAGE.—In the field of drainage as an activity of the Extension Service, the agents from 19 counties reported on work accomplished.

A number of systems have been planned with the assistance of members of the University staff and several systems have been installed. Farm advisors have been active in calling attention to the need for drainage and have conducted tours and investigations of drainage conditions. In a number of counties the county farm advisors have assisted in outlining drainage district boundaries and in organization work.

The active drainage projects on file in the State office are eight in number. Six of these projects had to do with education, showing the need for drainage, and were campaigns to bring before the people the necessity for prompt action. One project has to do with the organization of a flood protection district. The test plot at the Los Angeles County Farm was successful.

The activities of the farm advisors are summarized below:

			Systems planned		
	No.	*Attendance*	*No.*	*Acres*	*Installed*
Field Meetings	11	161	....	......	
Night Meetings	5	248	30	......	No
Tours	2	250	5	......	Yes
Farm Calls	52	......	7	119	Yes

District Organizations.—In Imperial County the last bond issue of the Imperial Irrigation District contained the sum of $2,500,000 for drainage. It was required by the Irrigation District Bond Commission that provision be made for general drainage of the lands of the irrigation district before bonds for additional irrigation development would be approved. The Extension Service aided materially in calling attention to the necessity for drainage and in the campaign before the bond election. The bonds carried by a good vote, and 14 miles of drainage ditches have been constructed.

Around the city of Bishop in Inyo County an irrigation district is in process of formation. Between 3000 and 4000 acres in that section are in need of drainage and it is proposed to do the work under the irrigation district when the same is organized.

In Los Angeles County there are three drainage districts, totaling 10,400 acres, in process of formation. The San Fernando Valley District works will be constructed by the city of Los Angeles when the rights of way for ditches are provided by the district.

The cost of drain tile has been a serious drawback to development of drainage in Napa County. Through the efforts of the farm advisor and farm bureau a local contractor has been induced to manufacture drain tile. Since the local production of tile has started the farm advisor has helped 20 farmers in planning drainage systems for their farms.

In Sutter County a drainage district of 1240 acres has failed to complete its organization, but the project will be continued.

A drainage district proposed for the Newhope section in Orange County has failed of organization, but the campaign will be resumed next year. The estimated cost of works was $160,000. A second district, containing 2500 acres, near Garden Grove, to be drained at a cost of $100,000, has been held up by court action.

In Ventura County a large district, containing 50,000 acres, near Oxnard, is under discussion. A project near Santa Paula for draining 300 acres is more favorably received by the owners concerned.

Alkali.—One of the most important problems among farmers in irrigated districts throughout the State is the control of alkali. In California there are over 2,000,000 acres of alkali affected land. During the past fifty years over 100,000 acres of productive land in the interior valleys have been rendered worthless because of the accumulation of alkali from over-irrigation. With the increased use of irrigation, the water table has been brought close to the surface over hundreds of square miles of the most productive lands in the State, and, if proper control methods are not put into practice, in a few years large additional areas will become worthless for crop production. Because of this, various counties are outlining projects for alkali control. During the past year 429 tests were made for data on alkali control. Two counties have secured results from demonstrations on alkali control.

In Tulare County one demonstration has been conducted to show how the deleterious effect of black alkali can be alleviated by the use of gypsum. The plot selected was an acre of alfalfa on recent alluvial Chino and Foster loams, where the alkali was so concentrated that a stand could not be secured. Five hundred and 1000 pounds of gypsum per acre was applied broadcasted and harrowed in, in the spring of 1921, with the result that a good stand of alfalfa was secured.

In San Joaquin County one demonstration was conducted on a portion of 400 acres of peat land, where the accumulation of 'white alkali' was so concentrated that only the most alkali-resistant weeds would grow. The method of treatment consisted in deepening the drainage ditches and flooding the land during the winter. As a result, an excellent stand of celery was produced. A large area of the peat lands in the delta of the San Joaquin River is more or less affected with 'white alkali.' This demonstration holds promise for such lands where, (1) the land is located close enough to a channel to secure adequate water for flooding, and (2) where sufficient grade is present to carry the water to the affected spot without excessive seepage losses.

In addition to the above, the following counties are doing considerable work on alkali: Imperial, Sutter, Santa Barbara, San Bernardino, Sacramento, Madera, Los Angeles, Kern, and Ventura. The problem is demanding that greater concentration of energy be diverted to this purpose, because the permanency of our agriculture is dependent upon the proper control of alkali. The work in these counties has been started too recently for conclusive results, but their observations will be continued until control measures are obtained. The alkali problem as a whole is commanding more attention each year throughout the State, because of increased water supplies, and also because of injury from excessive salts now beginning to show in many of the most productive sections.

Fig. 137.—Thirty soil moisture demonstration meetings were held with an attendance of 926 persons. Often the limiting factor in the growth of a crop is the lack of knowledge on the part of the farmer of the actual moisture conditions in the soil. The active use of the soil augur has been extensively advocated.

Cover Crops.—One of the most important factors in soil fertility is the organic content of the soil. Green manuring or the use of green cover crops, which is the incorporation of organic matter into the soil through plowing or similar operations, is one of the best means of maintaining or increasing the content of organic matter in the soil. Climatic conditions with low rainfall and its distribution throughout the year with relatively low atmospheric humidity such as prevail over most of the State have markedly increased the need for this constituent. The limited amount of barnyard manure available, and the increased plantings, have made it even more essential

that a workable plan of meeting this requirement by growing cover crops for green manure purposes be formulated. Studies in seeking the most suitable varities for winter, spring and summer use are being made, covering the principal soils and climatic belts of the State. Since nitrogen is likely to be the form of fertilization most needed in California soils, leguminous cover crops deserve first consideration, for through them we obtain not only organic matter but nitrogen also. Thirty-four counties reported 18,123 acres of cover crop turned under for green manure purposes compared with twenty-seven counties in 1921. The counties in which the work was done are: Alameda, Butte, Contra Costa, El Dorado, Fresno, Imperial, Glenn, Inyo, Kings, Kern, Los Angeles, Marin, Madera, Mendocino, Merced, Napa, Nevada, Orange, Placer, Riverside, Sacramento, San Bernardino, San Diego, Santa Barbara, Santa Cruz, Shasta, Sonoma, Stanislaus, Sutter, Tehama, Tulare, Yuba, Yolo, and Ventura. It was reported also that 1372 farmers grew 31,114 acres of green manure crops—a decided increase over previous years.

Winter Cover Crops.—The results of the various tests throughout the State indicate that bitter clover (*Melilotus indica*), common vetch (*Vicia sativa*), purple vetch (*Vicia atropurpurea*), and Canada field peas (*Pisum arvense*), have given the best results in California. Burr clover and broad beans (horse beans) come next. In general, *Melilotus indica* has proved most satisfactory. The rate of seeding for this variety is 12–20 pounds per acre. Purple vetch planted at the rate of 40–50 pounds to the acre gave an exceedingly heavy tonnage, but the large amount of seed necessary and its high price are limiting factors in its use. Common vetch does the best in the coast counties and south of the Tehachapi, but its use is extending to other parts of the State. Canada field peas are grown widely in the State and thrive in the Sacramento and San Joaquin valleys. Burr clover, 15 pounds to the acre, does well in most parts of the State, but thrives best where the soils are well supplied with lime. It does not produce so heavy a tonnage as the others. Three varieties of broad beans—the London, Valencia, and common horse bean—gave good tonnage in the coast counties and south of the Tehachapi. The first two named were tried out in Santa Cruz County and far outyielded the common horse bean. Further trials may bring these two varieties into more general use. Common vetch, field peas, and broad beans are troubled with aphis so that their use as cover crops may be limited. The winter cover crops should be planted in the later part of September or early October and plowed under the middle of March in citrus orchards and on dry-farmed land. In deciduous orchards

and on irrigated lands, it is feasible to let the cover crop mature where possible. The degree of maturity of cover crops when turned under must be governed largely by the kind of soil and the moisture supply. For heavy soils the crop should be more mature, so as to produce greater bulk, while light, sandy soils respond better if the cover crop is turned under while more succulent. Where water is scarce a winter cover crop should not be grown.

Spring Cover Crops.—Under certain conditions, a quick-maturing cover crop is desirable for spring use. Hubam clover, 15–18 pounds to the acre, *Melilotus alba* at the rate of 12–20 pounds to the acre,

Fig. 133.—Hubam clover cover crop in Merced County. Thirty-four counties reported 18,123 acres of cover crops turned under for green manure purposes.

Virginia soy beans, 40 pounds to the acre, and purple vetch have proved satisfactory. Hubam clover tested in three counties has yielded marked results and apparently has a place as a short-time green manure crop for potatoes and truck crops. The roots of the Hubam are very penetrating, so that on heavy or compact soils it is of considerable value. Spring cover crops should be planted in February or March and plowed under in July. Cover crops give better results when there is a rotation of the different varieties available.

Summer Cover Crops.—Summer cover crops have not been extensively grown in California, but, where water is available at reasonable cost, their use is being extended. During the past year the question of the influence of cover crops on the degree of frost injury during

the freeze in January, 1922, caused a decrease in subsequent plantings, but the results of the tests show that cover crops were not a factor in frost injury. The main cover crops tested are on the three varieties of cow peas—whip-poor-will, black-eye, and Brabham — which are seeded at the rate of 40–60 pounds to the acre. In addition soy beans, velvet beans, *Melilotus indica,* and both the biennial and annual *Melilotus alba* have proved satisfactory for summer cover crops.

Commercial Fertilizers.—The great variety of soils, climate, elevation, rainfall, atmospheric humidity, and crops grown in the state make it practically impossible to supply reliable information on the use of fertilizers as a result of experiments secured at any centrally located station. In order to systematize this work careful attention has been given to the above factors, using the soils map as a basis in arranging the tests for the different counties. This plan has greatly helped in preventing useless duplication and also in pointing out the limits beyond which the results cannot be expected to apply. U. S. soil survey maps and locally prepared soils maps are used as a base for the work under way.

Tests with commercial fertilizers were conducted in 39 counties, compared with 26 counties in 1921 and 16 counties in 1920. The farm advisors were consulted by 3225 farmers regarding the use of fertilizers and 5507¾ tons were used in the tests outlined. This is a marked increase over that of any previous year. The tests were arranged to cover many crops and soil types in the State. It is also planned to carry the tests through a sufficient number of years to cover climatic variations so farmers may use the results as a reliable guide in their practices. Fertilizer tests were made in all but one of the organized counties of the State.

On Field Crops.—Commercial fertilizer tests were conducted in 23 counties on field crops, and results indicate that much greater response was shown for such crops than where applications were made for fruits. Some difficulty was experienced in securing yields where farmers were depended upon to harvest the crops. Plans are now being worked out to correct this in the future where possible. The following results are among the most important obtained for field crops in 1922.

On Potatoes. Humboldt County.—One test, including six plots of $\frac{1}{10}$ acre each on old alluvial upland loam soil, gave the following results:

Sulfur	200 lbs. per acre,	yield of 5440 lbs. per acre
2½–10–5	500 lbs. per acre,	yield of 9840 lbs. per acre
0 –10–5	500 lbs. per acre,	yield of 10080 lbs. per acre
2½–10–5	800 lbs. per acre,	yield of 11920 lbs. per acre
Check		yield of 5300 lbs. per acre

The soil is low in fertility but uniform. The Beauty of Hebron was the variety used, and only marketable potatoes were considered in the yields. Yields for plots located on the recent alluvial and residual soils were not available when this report was written. The above results are in conformity with those obtained for this crop in the last three years' tests in this county.

Monterey County.—One test on potatoes, including five plots of $\frac{1}{10}$ acre each, was conducted on old alluvial upland loam soil with the following results:

Sulfate of ammonia	150 lbs, per acre,	yield of 4050 lbs. per acre
3–8–6	1000 lbs. per acre,	yield of 4260 lbs. per acre
0–6–6	1000 lbs. per acre,	yield of 3600 lbs. per acre
3–8–4	1000 lbs. per acre,	yield of 4300 lbs. per acre
Check		yield of 1440 lbs. per acre

All plots showed a marked increase over the check, and the greatest benefits come from the fertilizers containing nitrogen. This would be expected from the soil standpoint.

San Diego County.—One test on potatoes, with eight plots of $\frac{1}{10}$ acre each, was conducted on recent alluvial stream bottom loam soil with the following results:

Nitrate of soda 250 lbs. Superphosphate 300 lbs. Potassium sulfate 250 lbs.	per acre, yield of	9163 lbs. per acre
Sulfate of ammonia 150 lbs. Superphosphate 300 lbs. Potassium sulfate 250 lbs.	per acre, yield of	7460 lbs. per acre
Superphosphate 300 lbs. Potassium sulfate 250 lbs.	per acre, yield of	7250 lbs. per acre
Cottonseed 1000 lbs.	per acre, yield of	11250 lbs, per acre
Gypsum 500 lbs.	per acre, yield of	13375 lbs. per acre
Lime 2000 lbs.	per acre, yield of	10840 lbs. per acre
Sulfur 150 lbs.	per acre, yield of	8000 lbs. per acre
Check	yield of	6140 lbs. per acre

The soil was not as uniform as desired, nor was the irrigation water added equally in all places. The fertilizer was broadcasted between the rows and cultivated into the soil. Based upon the prices received at the ranch, the first treatment listed gave a gain over the fertilizer cost of $11.32 per acre, cottonseed meal an increase of $54.04 per acre, gypsum $67.07 per acre, lime $50.80, and sulfur $17.04 per acre. The second and third treatments gave a loss of $12.92 and $5.46 per acre, respectively. Early Rose was the variety used.

Los Angeles County.—Tests including 111 plots with varying forms of fertilizer were conducted in different parts of the county

on spring and fall plantings for potatoes. The accompanying results are for 71 plots in the spring planting. Returns for the fall crop were not available when this report was written. Standard fertilizers in general use for this crop were tested to determine, if possible, what combination and amount is best for the different soils.

Fish meal, 320 lbs., and sulphate of ammonia, 80 lbs., combined per acre on nine different soils gave an average of 5.39 tons. Cottonseed meal, 700 lbs. per acre, in eight trials yielded an average of four tons, cottonseed meal, 500 lbs., and sulphate of ammonia, 80 lbs., combined per acre in eight trials gave an average yield of 5.2 tons, fish meal at 500 lbs. per acre gave an average yield of five tons in eight trials, tankage at 500 lbs. per acre in eight trials produced 4.45 tons, complete fertilizer 4–8–3 at 1100 lbs. per acre in one trial gave 4.8 tons, and a 4–8–4 mixture at 800 lbs. per acre gave 5.4 tons compared with an average of 3.2 tons per acre for the nine checks. Results show favorable increases for all the mixtures used and also that with a price of only 1 cent per pound for potatoes it pays to use organic nitrogenous fertilizers in quantities amounting to $15.00 to $20.00 per acre.

The results obtained so far in fertilizer tests on potatoes indicate that, except for the influence of organic matter, none of the treatments given can be recommended beyond the soil type boundaries in the region in which the results were obtained. It therefore appears necessary that complete tests for reliable results be conducted on each soil type in each locality where potatoes are grown.

On Alfalfa. Mendocino County.—One test with seven plots of ½ acre each on a recent alluvial river bottom loam gave the following results:

	Yield			
	1919	1920	1921	1922
Lime, 2000 lbs. per acre	2846 lbs.	1800 lbs.	3240 lbs.	2380 lbs.
Gypsum, 250 lbs. per acre	3780 lbs.	3720 lbs.	5380 lbs.	3140 lbs.
Sulfur, 200 lbs. per acre	4160 lbs.	4400 lbs.	7240 lbs.	5680 lbs.
Superphos, 250 lbs. per acre	4340 lbs.	2900 lbs.	5180 lbs.	2360 lbs.
Superphos and Gypsum {2250 lbs. per acre, 250 lbs. per acre}	5000 lbs.	3560 lbs.	6560 lbs.	3640 lbs.
Lime and Sulfur {2000 lbs. per acre, 200 lbs. per acre}	6440 lbs.	5100 lbs.	6400 lbs.	5640 lbs.
Check	3400 lbs.	1780 lbs.	3060 lbs.	2640 lbs.

The weight given is in pounds per acre. The treatments were applied in 1919, and subsequent yields are from the residual effect of the 1919 application. Sulfur was tried on several other crops in this county but no beneficial results were obtained.

Stanislaus County.—Six tests with a total of 29 plots gave the following results for alfalfa, in average yield per cutting per acre:

Test I, for 3 years:

Lime 1000 lbs. Sulfur 200 lbs.	per acre,	3240 lbs. average per cutting
Lime 1000 lbs.	per acre,	2304 lbs. average per cutting
Sulfur 200 lbs.	per acre,	2434 lbs. average per cutting
Check		2190 lbs. average per cutting

Test II, for 2 years:

Lime 1500 lbs. Sulfur 150 lbs.	per acre,	3785 lbs. average per cutting
Lime 500 lbs.	per acre,	3115 lbs. average per cutting
Sulfur 150 lbs.	per acre,	3400 lbs. average per cutting
Gypsum 250 lbs.	per acre,	2943 lbs. average per cutting
Superphosphate 300 lbs.	per acre,	3119 lbs. average per cutting
Check		3001 lbs. average per cutting

Test III, for 2 years:

Lime 500 lbs. Sulfur 150 lbs.	per acre,	4338 lbs. average per cutting
Sulfur 150 lbs.	per acre,	2908 lbs. average per cutting
Gypsum 250 lbs.	per acre,	3242 lbs. average per cutting
Superphosphate 300 lbs.	per acre,	3376 lbs. average per cutting
Check		3301 lbs. average per cutting

Test IV, for 2 years:

Lime 500 lbs. Sulfur 150 lbs.	per acre,	3555 lbs. average per cutting
Sulfur 150 lbs.	per acre,	2744 lbs. average per cutting
Gypsum 250 lbs.	per acre,	2255 lbs. average per cutting
Check		2189 lbs. average per cutting

Test V, for 2 years:

Lime 500 lbs. Sulfur 150 lbs.	per acre,	4845 lbs. average per cutting
Lime 500 lbs.	per acre,	3576 lbs. average per cutting
Sulfur 150 lbs.	per acre,	4394 lbs. average per cutting
Gypsum 250 lbs.	per acre,	3619 lbs. average per cutting
Superphosphate 300 lbs.	per acre,	3535 lbs. average per cutting
Check		3268 lbs. average per cutting

Test VI, for 2 years:

Lime 500 lbs. Sulfur 150 lbs.	per acre,	2690 lbs. average per cutting
Sulfur 150 lbs.	per acre,	2262 lbs. average per cutting
Superphosphate 300 lbs.	per acre,	2405 lbs. average per cutting
Check		1748 lbs. average per cutting

The first and last tests were carried on at Tegner on Fresno sandy loam, the second at Patterson on Yolo clay loam, the third at Hughson on Fresno sandy loam, the fourth at Denair on Fresno sandy loam, the fifth at Salida on Fresno sandy loam. An average of six cuttings

per year gave an increase for the lime and sulfur plots of 4½ tons per acre over the check per year. In most of the tests the influence of gypsum disappeared after the third cutting and superphosphate declined rapidly after the fourth crop. The influence of lime and sulfur combined increased in each successive crop from spring to fall and the yield over check was greater the second year than the first. The first test was started in 1920 and the influence of the lime and sulfur combined treatment in the third year showed an average increase of ½ ton per acre per cutting over the check.

Fig. 134.—Hairy vetch and oats. The results of a fertilizer test with superphosphate, Butte County. Application, 500 lbs. per acre, planted fall of 1922, pictures taken May 8, 1923. Soil, lava ash. Elevation about 1500 feet. Left, unfertilized. Right, fertilized. Local tests are necessary to determine soil needs.

Kern County.—Lime 400 lbs. and sulfur 100 lbs. combined per acre on Pond clay loam showed no increase over the check for alfalfa. Sulfur alone at 100 lbs. per acre in the same test gave an increase of nearly one ton per acre. Another test with the same mixture for alfalfa on Hanford sandy loam gave an increase of ½ ton over the check. While sulfur alone also increased the yield by ½ ton. A test with the same mixture for alfalfa on Delano sandy loam gave no increase. The three tests above were started in 1922.

Merced County: Test I.—Lime 450 lbs. and sulfur 110 lbs. per acre combined, started in 1922 at Delhi, gave a total yield per acre

of alfalfa of $10\frac{1}{2}$ tons compared with 10.3 tons for sulfur applied at the rate of 220 lbs. per acre, and $4\frac{1}{10}$ tons for the check. This test was on Madera sand.

Test II.—At Amsterdam a test for alfalfa on Madera sandy loam with the same combination of lime and sulfur as above gave a total of 6.6 tons per acre compared with 4.4 tons per acre for the check.

Test III.—At Gustine, lime 500 lbs. and sulphur 150 lbs. per acre combined on Yolo clay loam, gave a total yield of 5.8 tons per acre of alfalfa compared with 5.7 tons for sulfur applied at the rate of 220 lbs. per acre and 5 tons per acre for the check.

San Joaquin County.—Lime 500 lbs. and sulfur 100 lbs. per acre combined for alfalfa on Fresno sandy loam applied after the second cutting in 1922 gave no increase over the check. Sulfur alone at 150 lbs. per acre in the same test gave ½ ton increase per acre over the check. Superphosphate, 300 lbs. per acre, gave ¾ ton increase over the check. Gypsum at 300 lbs. per acre gave nearly ¾ tons per acre increase over the check. Manure at 1800 lbs. per acre gave ¾ tons increase over the check.

Yolo County.—Lime at 1000 lbs. and sulfur at 180 lbs. per acre combined for alfalfa on Yolo silt loam gave no increase over the check in 1921, while sulfur alone in the same test at 150 lbs. per acre gave an increase of $\frac{3}{10}$ ton per acre over the check. In 1922 the lime and sulfur plot gave an increase of 1.3 tons per acre over the check, and the sulfur alone an increase of 1.6 tons per acre. Lime hydrate alone at the rate of 200 lbs. per acre gave no increase in this test in 1921 and an increase of 2.6 tons per acre over the check in 1922. This was the residual affect of the 1921 application.

Lime and sulfur for alfalfa on a recent alluvial stream-bottom loam in Humboldt County, in a test started in 1918 with 200 lbs. of sulfur per acre on alfalfa, showed a greatly increased yield each year over the check. The residual effect of this application gave a yield of $7\frac{3}{4}$ tons per acre in 1922 compared with $4\frac{1}{4}$ tons per acre for the check. The soil is a recent alluvial stream-bottom soil. No yields are available for the other years.

In addition to the above it was observed in Stanislaus County that gypsum applied to tight or slickened spots in fields had a tendency to improve such areas.

Thirteen other counties have tested lime and sulfur and sulfur alone on alfalfa, but as yet no beneficial results have been noted. It is evident from the tests so far conducted that the results obtained from these materials cannot be recommended for broad use throughout the state and each locality must use the results obtained locally

as a guide to its operations. So far as the field tests have gone, there appears to be some relation between soils derived from granites and basic igneous rocks as to response from lime and sulfur on alfalfa. The need for these ingredients appears to be connected with the two above formations.

On Grain: Monterey County.—Sulfate of ammonia 100 lbs. and superphosphate 100 lbs. per acre combined gave a yield of 1919 lbs. of wheat on one acre compared with 1547 lbs. for the check. This is the only plot in nine where various mixtures of fertilizers were used which showed an increase over the check. Eight plots in three tests with different mixtures of fertilizers for barley on recent alluvial loam soils gave no increase over the check.

San Joaquin County.—Straw, 3.7 tons per acre, applied in the late fall and plowed under on San Joaquin sandy loam gave a yield of 3.8 tons of hay compared with 3.4 tons for the check per acre. Horse manure, 5.3 tons per acre, plowed under in the fall on the same type of soil gave a yield of 3.6 tons of hay compared with 3.2 tons for the check per acre. Sheep manure, 1200 lbs. per acre, yielded 5.3 tons; burned stubble, 2.4 tons; cow manure at 5.6 tons per acre yielded 3.9 tons; sulfate of ammonia at 100 lbs. per acre 3.7 tons, and check 3.2 tons.

Nearly all of the benefits obtained so far in the use of fertilizers on grain by the counties indicated that nearly all the increase in yields both for hay and grain have been due to the nitrogen in the mixture, and where manure or other organic matter has been applied.

Superphosphate at 300 lbs. per acre on a recent alluvial loam soil at Shively, Humboldt County, gave a yield of 34 tons of half long white carrots compared with 30 tons per acre for the check. Potash had no effect upon the yield.

Nitrate of soda at 350 lbs. per acre applied to chili peppers on a sandy loam in Orange County gave a 25 per cent increase in yield over the check. Superphosphate showed no benefits. Nitrate of soda alone or combined with superphosphate gave no increase in Orange County on a recent alluvial sandy loam when applied to sugar beets.

On Fruits.—Fertilizer tests were conducted in 23 counties on fruits. The results vary widely according to the variety of fruit and kind of soil. Different mixtures were applied for direct benefits by the practice of clean culture following the application and for indirect benefits by applying the material to a cover crop and then turning the cover crop under. The following results are most prominent in this line of work.

Napa County.—A 0–4–8 mixture with 750 lbs. added per acre for Imperial prunes on a residual loam applied in February gave 260 lbs. of dried prunes compared with 245 lbs. for the check. Ten trees were in each plot. Four per cent of nitrogen added to the above mixture gave no increase over the superphosphate and potash alone. Manure at 20 tons per acre on one plot and 300 lbs. of sulfate of ammonia on one plot, added March 30, gave practically no increase over the check on a residual loam. Thirteen plots of French prunes on an old alluvial loam showed no increase for nitrate of soda or sulfate of ammonia. A mixture of 8 per cent of potash and 4 per cent of superphosphate added at 800 lbs. per acre in March, followed by

Fig. 135.—Alfalfa in Merced County fertilized with lime and sulfur. Lime, 450 lbs. per acre. Sulfur, 110 lbs. per acre. Left, unfertilized. Right, fertilized. Local tests are necessary to determine soil needs.

clean culture for 26 trees, gave $113\frac{1}{2}$ lbs. compared with $75\frac{1}{3}$ lbs. for the check in green fruit. Manure at 20 tons per acre gave an increase of 21 pounds of green fruit over the check for 25 trees in each plot.

Sonoma County.—Applications of nitrate of soda, superphosphate, potash, manure and combinations of nitrogen, superphosphate and potash in orchards in late fall were made to note their effect upon the native cover crop. Wherever nitrogen or manure was added a rank growth of grass and weeds occurred. Potash showed little if any benefits, while superphosphate in every instance caused a heavy growth of burr clover and scant grass. The test was conducted on an old alluvial loam southeast of Sonoma. No effect on tree or fruit was noted.

A two-ton application of ground limestone per acre on clay adobe soil and on a loam and silt loam set to prunes resulted in a heavy native clover crop. No benefits were noted in the trees nor fruit.

Nitrate of soda on plots ranging from 10 to 50 lbs. per tree for apples on a residual sandy loam near Sebastopol gave a rich, dark green foliage, but not an increase in yield.

Eight different tests in Monterey County with fertilizers on apples, apricots, pears, and gooseberries showed no benefits.

A 4–4–8 mixture added in February at 560 lbs. per acre on a residual loam in Napa County gave 1192 lbs. of green pears compared with 826 lbs. for the check. Each plot contained ten trees. Two additional tests with a complete fertilizer on the same kind of soil for pears give similar increases. Potash and superphosphate combined with 10 lbs. added per tree for pears gave 12½ per cent increase in green pears over the check.

Sulfate of ammonia added to peach and almond trees in Merced County on Madera loam in March and irrigated gave no increase in yields, but in some instances caused the fruit to mature later. The same mixture was added to grapes in two tests, but gave no increase in 1922.

An extensive series of tests were started in Contra Costa County in 1922 with fertilizers for pears, apricots, prunes, grapes, and walnuts on Yolo clay loam, Dublin clay loam and loam, but no increase in yields were received this year.

Sutter County.—Bonemeal at 8 lbs. per tree for prunes gave a yield of 97 boxes per acre, with 64 boxes for the check.

A marked increase in growth of two-year-old prune trees was also noted where a complete fertilizer was applied at the rate of 2500 lbs. per acre.

Humboldt County.—Three hundred pounds of superphosphate per acre on raspberries on a recent alluvial loam gave an increased yield of 970 lbs. over the check per acre. The same treatment gave no results on strawberries.

A 2½–10–5 fertilizer added at 800 lbs. per acre for strawberries gave an increase in yield of 270 lbs. per acre over the check. The same treatment for loganberries gave 960 lbs. increase in fruit per acre over the check.

The amount of commercial fertilizer used in citrus orchards in California greatly exceeds that used on all other agricultural crops combined. No definite information has been secured regarding the amount and combination of material required for this crop for the different soils and climates, and as a result a colossal waste has occurred from applying mixtures which have given no benefits. High land values, a scarcity of manure, and the exacting requirements of citrus trees have developed a great demand for specific information

regarding the proper combination and amounts of fertilizer which will meet the needs of the industry. To this end numerous tests have been outlined in the different counties concerned to extend over a sufficient period of time so the data obtained might serve as a reliable guide to farmers.

Orange County.—Two tests containing 30 plots on Hanford sandy loam and Yolo clay loam were started in the spring of 1922, using manure, bean straw, dried blood, sulfate of ammonia, superphosphate, potash, lime, gypsum, and sulfur in various combinations. Iron sulfate was also added to one plot to note its effect upon chlorosis of citrus. No results are yet available from these tests except for the physical improvement of lime on heavy soils and a greater vigor and better color of foliage where gypsum was applied.

Los Angeles County.—Citrus fertilization is an important project in the county and to meet the needs of the industry locally 64 plots have been outlined on which different kinds and combinations of fertilizers and times of most effective application are being studied. No results are available yet from the tests because of insufficient time. The tests will be followed for at least five years.

Ventura County is conducting similar tests on oranges and lemons. Blood meal and manure combined began to show improvement in the color of the foliage and caused a heavier setting of fruit late in 1922. These tests will continue for a number of years.

Santa Barbara, San Bernardino, San Diego, Tulare, Sacramento, and *Butte* counties are conducting tests with fertilizers on citrus trees, but no measurable results have been shown so far except a general improvement in soil and growth of trees from an application of five tons of lime per acre on lemons in Santa Barbara County.

Five counties have adopted fertilizer programs for walnuts, but no positive results are apparent yet. The tests will be continued for a period of years to obtain the role of fertilizers in production for this crop.

LIME.—Interest in the use of lime is increasing throughout the state, as is indicated by the fact that 283 farmers used 3881 tons in 30 counties in field tests during 1922, compared with tests in 16 counties in 1921. The principal studies with lime have been to note its physical effect upon heavy textured soils, its role in the decomposition and preservation of organic matter, and its relation to bacterial action, soil nutrients and soil sanitation. Practically every county noted decided benefits in the physical condition of loams, clay loams and clays where lime was applied in amounts above ½ ton per acre.

In Sonoma County three tests of lime applied at the rate of 2 tons per acre in 1919 improved heavy soils physically and in each year since has resulted in a heavy native cover crop, while the adjoining untreated orchards have shown practically no cover crop growth among the trees.

In Mendocino County lime alone on recent alluvial soils gave negative results for alfalfa, but when added with sulfur gave a marked increase over the sulfur plot and the check plot. Two carloads of ground limestone were used in that county in tests in 1922, and, except for the beneficial results when added with sulfur. Only one other test with lime alone showed improvement, and that was in the growth and vigor of vines on a residual soil.

In Contra Costa County applications of 1½ and 2 tons per acre on a clay loam soil resulted in larger and finer heads of lettuce.

In Stanislaus County lime alone gave no increase for alfalfa, but when added with sulfur gave greatly increased yields over sulfur alone and over check plot.

Sutter County estimated a 20 per cent increase in yield of barley on a clay loam soil where 2 tons of lime had been applied per acre. The same application for grapes on a clay loam caused the soil to receive water more readily and gave an estimated increase in yield of 80 to 100 per cent over the check. *Melilotus indica* on the same type of soil with 2 tons of lime per acre gave a yield of 6¾ tons per acre compared with 3 tons per acre where 1 ton of lime was added.

Santa Barbara County noted a decided improvement in vigor and growth of an old lemon orchard in the fall of 1922 where 1½ tons of lime had been applied in March and the orchard irrigated five times during the year.

In Monterey County limewater from sugar beet lime greatly improved the physical condition of the heavy clay loam soils in the Salinas Valley. This resulted in heavier yields of beets and other annual crops the following year. No improvement, however, was noted where lime was added to deciduous fruit orchards or to oats on upland soils.

In Humboldt County applications of 2 tons of lime per acre gave increased yields for oats and alfalfa, but its greater benefit was where supplemented with manure.

Results for the state as a whole indicate that the indiscriminate use of lime, regardless of soil or crop, is not warranted. Also that lime alone has increased yields in a very few places. That for best results its use should be supplemented with organic matter. Also that marked results have been obtained where lime is added with

sulfur for alfalfa. Furthermore, that it frequently requires more than one year for results to show on crops. It is also evident that marked improvement has resulted in the physical condition of heavy soils in almost every instance where tests have been made; that the response of lime depends upon its degree of fineness, which is determined by its being able to pass through a 60-mesh sieve; that the value should be determined by the percentage of calcium present, and that its use cannot be expected to increase greatly until it can be supplied at a lower price.

Fig. 136.—The people everywhere are greatly interested in the tests on various fertilizers. The indications point to the fact that a large number of these tests must be made locally.

GYPSUM.—The use of gypsum has not increased so fast as lime, largely because a higher price is charged for the former. It was tested by 106 farmers in 17 counties in 1922 and nearly 400 tons were used in the trials.

In Tulare County applications of 500 lbs. and 1000 lbs. per acre on black alkali areas resulted in a good stand of alfalfa except in badly affected spots.

In Yuba County the greatest benefits were obtained where 100 lbs. of gypsum were applied with a heavy application of manure as a surface dressing on an old alfalfa field in 1922. The field was nearly run out when the application was made. The treated area gave a yield of 11 tons per acre for the year.

In Orange County 5 tons of gypsum per acre applied around orange trees in 1921 improved the vigor of the trees and gave a darker color to the foliage.

In San Joaquin County one test gave the following results: gypsum 300 lbs., and manure, 9 tons per acre, gave a yield of 5.4 tons of alfalfa per acre; manure at 9 tons per acre alone, 4.6 tons per acre; gypsum alone, 300 lbs. per acre, 4.3 tons per acre; and the check 4.3 tons per acre. These results correspond with those in Yuba County, namely, that gypsum and manure combined gave the greatest yields.

In Stanislaus County the best results were obtained on black alkali areas where gypsum combined with manure or bean straw was applied.

In a number of counties where gypsum was applied to heavy and tight soils, physical improvement was noted. When applied to alfalfa its lasting effects are not so long as where lime is applied. It has shown improvement on tight soils and cannot be replaced by lime for the correction of black alkali troubles. Several years' tests with this material are necessary before definite conclusions can be drawn regarding its value on the different soils and crops for California. As a rule its most beneficial effects show on soils derived from granite and basic igneous rocks, and in this respect it is similar to sulfur.

Subsoiling and Blasting. Soil improvement studies throughout the state show that physical fitness of the soil is one of the foremost essentials for maximum yields and long-lived orchards. Also that the 2,000,000 acres or more of old alluvial soils in the state which have developed heavy compact subsoils are not sufficiently permeable to air, roots and water for best results. There are also large areas of recent alluvial soils which have developed a compact plow pan several inches below the surface which also greatly interferes with water penetration and proper root functioning. Such layers need to be broken up for best results. Subsoiling has proven the best temporary means for relieving this condition, and to this end 413 farmers subsoiled 7785 acres in 30 counties in 1922. The proper depth and distance apart of furrows in subsoiling depends upon individual conditions, and no general rule can be followed. Where a plow pan is present it is seldom necessary to subsoil to a greater depth than 12 to 15 inches, but where a heavy subsoil is present it may be advisable to loosen the material to a depth of 22 to 24 inches. Economy as related to benefits is the important thing to keep in mind in this operation. Where an intermittent hardpan is present or where it is only 4 to 6 inches thick it is usually advisable to attempt to break it up by subsoiling. Attempts to break thicker layers than this have

not proven advantageous nor of any great value. The cost in breaking layers a foot thick and two feet below the surface is about $18 per hour for power and then only a scratching of the top of the compact layer results.

In Sacramento County it has been observed that for vineyard planting where the vines are set 10 x 10 feet, the subsoil furrows can be run 10 feet apart. For rejuvenation work on the above system of planting, good results have been obtained by running two furrows between each two rows. For orchards, one to three furrows between each two rows of trees has given good results. In this county the practice has been to subsoil when the land is driest and to follow the subsoiler immediately with a small stream of water in each subsoil furrow. A large stream tends to seal the surface and prevent proper percolation. After irrigation cultivation to a depth of 8 to 12 inches has given good results in loosening the top soil and reducing evaporation. In nearly all of the tests the frequency of irrigations was greatly reduced and the total amount of water used much less than before. Both deciduous and citrus orchards showed greatly increased growth and vigor following subsoiling. The practice has become very extensive in this county, following the first tests three years ago, and no negative results are reported, although many of the roots were severely pruned. The cost in this county varied from $5 to $15 per acre, depending upon the number and depth of furrows and the compactness of the subsoil.

San Benito County subsoiled 135 acres of orchards in three tests in 1922 as a result of a test carried out on a 400-acre tract the year previous. The 1921 test shows that the soil takes water much better, and a better growth in crops has followed.

In Yuba County 12 tests in subsoiling, covering 628 acres, have been conducted. Most of this work was in preparation of land for orchard and vineyard planting in the spring of 1922. In all instances much more thrifty trees and vines resulted, compared with areas not subsoiled.

San Joaquin County conducted six tests, covering 80 acres. One test on alfalfa, near Tracy, subsoiled 14 inches deep in 1920, showed the following yields:

1920	Subsoiled 4½ tons, check 2 tons per acre
1921	Subsoiled 10 tons, check 3 tons per acre
1922	Subsoiled 11 tons, check 6 tons per acre

The other tests were on grain land, orchards, vineyards, and bare land preparatory for orchards. Following subsoiling the land received water much more readily, which helped the crops materially.

Two tests were located in Kings County in a peach orchard and vineyard. Both were subirrigated and no benefits resulted in 1922. It is difficult to see how subsoiling could help such a condition.

Los Angeles County conducted 165 tests in subsoiling on 3000 acres in 1922. The practice there has proven a temporary means of improving the mechanical condition of the soil and permitting better moisture and root penetration. The crops on the areas subsoiled have shown better than on untreated areas.

Fig. 137.—Subsoiling on hardpan land often brings results. Running irrigation water in a subsoil furrow, Sacramento County.

El Dorado County conducted two tests in subsoiling in orchards in 1921 and in each test no winter die-back or sour sap occurred, while in untreated adjoining orchards considerable losses from these causes occurred.

Tulare County conducted fifteen tests in subsoiling in 1922, one on a recent alluvial Hanford fine sandy loam. The depth was 16 to 18 inches and the testing was done in February. In March the field was set to muscat rootings. Two rows were kept as a check. The

treated soil showed better water penetration until about August, and after that no difference could be noted. This test does not seem to be of any value, because the soil was not seriously deficient in its physical features, and the operation was conducted in the wettest part of the year, when the best work is not done. Grape rootings do not draw deeply the first year and might easily not be benefited.

One test was conducted in a mature vineyard on a recent alluvial Foster sandy loam. The standards were set so they went only 8 inches deep next to the vines and 22 inches deep in the middles. The work was done in October, 1921. The following year much better water penetration resulted, but no difference could be seen in the vines or fruit until late summer. At this time the check plot showed earlier ripening of its fruit and a drying of foliage. This necessitated an early picking of the fruit with a low sugar content. The subsoiled plot yielded 115 tons of raisins on 53 acres and the check plot 80 tons on 52 acres. After harvest the subsoiled vines showed a healthy green foliage. It is considered that the retention of the foliage later in the year is a material benefit in maintaining longer lived vines.

In 1921 a one-acre plot of 8-year-old orange trees on San Joaquin loam was subsoiled 24 inches deep on the north and south sides of each row of trees and within 4 feet of the trunks. Irrigation followed immediately afterward. Before treatment the trees were making practically no growth—were less than half the size of the other trees in the orchard—and the foliage was yellow. In 1922 these trees made a very good growth and showed a good color of leaves.

In addition to the above benefits, subsoiling has greatly stimulated cover crops by permitting the roots to enter the soil more deeply, giving them a greater feeding area. This was pronounced where subsoiling had been done in a citrus orchard in Fair Oaks, Sacramento County. In December, three months after subsoiling, the native cover crop stood 2 feet tall along the furrows compared with 4 inches along the tree rows where the soil had not been disturbed. Knowledge in subsoiling is progressing rapidly and relatively definite information is now available regarding the best way of performing this phase of soil management.

Blasting is another form of subsoiling, but it is a more expensive operation and is usually confined to the preparation of soil for orchard and vineyard planting. It is also used in breaking the plowpan or hardpan near the trunks where subsoiling cannot be done safely. Tests were conducted by 138 farmers on 1793 acres in 20 counties in 1922. The results show that blasting should be done at a time when the soil is quite dry, in order to shatter the underlying compact

layers. Low grade dynamite of 20 per cent strength has given best results, as it explodes slowly and shatters the soil better. It has an advantage over subsoiling where large roots are present, because if the charge is properly placed it will not seriously disturb the roots.

Soil Inoculation.—Nearly all kinds of legumes do well on the recent alluvial soils in California and the half dozen counties conducting tests on inoculation have shown no benefits. The old alluvial soils, however, are usually very low in organic matter and their exposure to the high summer temperatures for a long period makes them less favorable for starting leguminous crops. Results show that it requires two or three years to establish a good stand of vetch and certain others of the legumes on such soils. It takes about this length of time to get the soil well aerated and livened up, whether organic matter or inoculation from commercial cultures is added. In some instances, however, organic matter has made it possible to secure a favorable growth the first year, and it is reported that some benefits have been derived in certain instances where commercial inoculation material has been used.

CROP PRODUCTION

There were 2133 demonstrations in crop production, of which 1603 were reported as completing. One thousand fifty-one demonstration meetings were conducted by farm advisors at which 34,667 persons attended. There were 11 organizations or associations relating to crops that farm advisors assisted in forming in 1922, with a reported membership in ten of them of 1122 persons; one had not completed its organization at the time of this report. There were 87 boys and girls' clubs organized, incident to crop production, with a membership of 590, 461 of whom reported. These clubs included contests in corn, potato, garden, grain sorghum, grape acre, grape nursery, orchard management, strawberry and tomato growing.

Field Crops.—A total of 621 farmers were reported to have been assisted in securing 32,145⅓ bushels of improved seed. Eighty-eight farmers were reported to have 27,239 bushels of improved seed for sale.

Wheat.—Thirteen counties report work done on wheat variety, cultural, and disease control demonstrations. The farm advisors reported that on 224 farms, representing 19,903 acres, wheat growing was introduced or farm practice relative to wheat culture improved. Most of the variety testing has been an attempt to establish Early Baart and Bunyip wheats in their most favorable soil and climatic environment.

Early Baart.—Ten trials in four counties on 204 acres indicated that Early Baart is better adapted to the soils of medium texture, and in one test in Alameda County it did fairly well on heavy Dublin adobe, yielding 1100 lbs. per acre. In general, however, it seems to yield best on the lighter soils. The planting dates ranged from November 3 to December 12, seeded at the rate of an average of 78 lbs. per acre. The harvest dates were uniformly between July 9 and 15. The average yield of all tests was 1867.8 lbs. per acre.

Fig. 138.—A test of vetch and barley to be cut for hay. Green weight, 14 tons per acre. Napa County.

Bunyip is a variety of wheat which seems to require, and does best on the more fertile bottom lands of the silt to light clay loam textures in the coastal regions. Two tests in Contra Costa County on Montezuma and Dublin adobe soils with Hard Federation have an unfavorable comparison; Hard Federation yielding 410 lbs. per acre more than Bunyip. Six tests in four counties on 624.11 acres yielded an average of 1828.5 lbs. per acre. It required a rather heavy seeding of an average of 95 lbs. per acre, planted and harvested at about the same dates as Baart, with a tendency to be a few days earlier.

Hard and White Federation wheats were only tried to a limited degree in the state as a whole. In three counties extensive tests were made with 28 varietal selections suggested by the Agronomy Division

the College of Agriculture, in an attempt to discover a new variety adaptable to a particular condition of soil and climate. In Solano County a test was made to find a variety better adapted to Montezuma adobe hill lands; in Kings for the clay soils of the Tulare Lake bottom, and in Los Angeles for the wind-swept, light sandy soil of the Antelope Valley. The order of preference in each county is as indicated below. These tests will be continued next year in the same manner, i. e., by planting each variety in triplicate in rod rows.

County	Order of Pref.	Variety	Identification number	Remarks
Solano	1	Egypt. Baart	K.P. 24	Montezuma adobe
	2	Rymer	K.P. 40	Rust-resistant Australian
	3	Cleveland	K.P. 42	High-yielding Australian
	4	Thew	K.P. 39	Extreme rust-resistant early Australia
	5	Marshall 3	K.P. 31	High-yielding Australian
	6	Davis Little Club		Selection of Little Club
Kings				Sac. clay, planted Dec. 8, harvested July 21
	1	Canberra		High-yielding Australian wheat
	2	Indian	24	Drought-resistant variety from India
	3	Bunyip	D. 680	
	4	Early Baart	K.P. 24	South African Wheat
	5	Cowra	3	Australian variety
	6	Marshall 3	K.P. 31	
Los Angeles				Cajon sandy loam-Antelope Valley
	1	Indian	24	
	2	White Fed	51	Planted Feb. 15
	3	Sonora	00	Harvested July 3
	4	Pusa	4	Very early drought-resistant variety (from India)
	5	Bunyip	K.P. 22	
	6	Commonwealth	K.P. 34	High-yielding drought resistant

Barley: *Mariout.*—The testing, introduction and demonstrations of Mariout barley, a variety recommended by the Agronomy Division of the College of Agriculture, continues to hold a prominent place in the grain-growing districts of the State. The year 1922 was the fourth year that Mariout has been commercially grown in the State. The general conclusion as to its adaptability has been that it is a better yielding barley for the dry areas of the grain-growing counties of the State, especially on the lighter soils. It has proved its popularity, because it is particularly drought resistant. These conclusions were again borne out in 1922. In Santa Barbara and in San Benito, with four trials, on 48 acres checked with Coast Common barley,

Mariout outyielded by an average of 725 lbs. per acre. These trials were on residual, recent alluvial and sandy loam soils in the south coast regions of the state. During the past year, however, the majority of tests in the state have been in an effort to determine the adaptability of Mariout on some of the drier but heavier soils. Six counties reported 23 tests on 941 acres. The limits of planting dates seem to be from September 25 to February 1, with a majority of plantings at the rate of seeding of 76 lbs. per acre, between December 15 and January 15. The dates of harvest ranged from June 14 to August 22, with a majority between June 20 and July 22. The average yield on these 23 tests was 1822 lbs. per acre. Common barley was checked against these trials on 1864 acres and gave an average yield of 1110 lbs. per acre, or a difference of 712 lbs. in favor of the Mariout. The Mariout situation in the state may be summed up in a statement by the Monterey County farm advisor, who reports as follows: "Although this was a hard year for Mariout barley, being extremely wet and cold during the early stages of its growth, it again demonstrated its superiority over Common barley. There were cases where Common made a higher yield, but this was the exception rather than the rule. Mariout is regarded as the standard barley in sections where it is adapted. There is no means of estimating the acreage now sown to Mariout. It is a thing which has been extended to every grain grower in those parts of the county where it will succeed. We might consider that part of the project closed. We are now interested in keeping pure the Mariout we have, and in getting improved strains. The farm advisor made 59 selections, which will be planted next year in the plant to the rod row method in an attempt to get a pure, higher yielding strain."

Tennessee Winter.—Whereas Mariout barley is adapted to medium to light soils and light rainfall, Tennessee Winter seems to be best suited to the opposite conditions. In Mendocino, Contra Costa and Alameda counties, where either a heavy soil or a heavy rainfall condition prevails, Tennessee Winter barley outyielded both Common and Mariout. In the above four counties, in two trials on a clay loam soil, on 33 acres it yielded an average of 48 lbs. better than Mariout, while in eight trials checked with Common barley it gave a better average yield of 155 lbs. per acre. The best results seemed to be obtained when the planting was done about December 15 and the harvesting between July 3 and 25. The average rate of seeding per acre for all trials was 78 lbs. per acre.

Other Variety Tests of Barley.—Considerable work has been done by the Kings, Los Angeles, Monterey, and Solano County farm

advisors in testing out the value of a series of 25 hybrids and special selections of common varieties supplied by the Agronomy Division. Scald resistance and adaptability to heavy, wet, cold soils are the particular characteristics desired in these tests. The hybrids are a cross of Coast Common barley with Cape barley, which seem to be scald-resistant, non-shattering, resistant to lodging, and high yielders of grain, but short in height. The spikes are club-shaped. The Tennessee Winter strains have been selected for their resistance to scald and drought, while they yield a good quantity and quality of grain and are also adapted to wet and cold soils. These varieties were tested by the rod-row method of planting in triplicate and checked with Coast Common barley. The following table gives the order of preference in the above four counties:

County	Order of Pref.	Variety	Identification number	Remarks
Monterey				Old alluvial valley heavy loam. Clay loam subsoil
	1	Hybrid	1519	
	2	Trebi	c–936	
	3	Mariout	c–2275	U. S. D. A. Introd. from Asiatic Turkey scald resistant selection
	4	Hybrid	1511	
	5	Tenn. Winter	c–2272	
	6	Tenn. Winter	c–2273	
Kings				Sacramento clay
	1	Hybrid	1529	
	2	Tenn. Winter	c–2273	
	3	Tenn. Winter	c–2272	Planted December 8
	4	Hybrid	1521	Harvested July 21
	5	Hybrid	1516	
	6	Hybrid	1528	
Solano				Montezuma heavy adobe
	1	Hybrid	2776	
	2	Hybrid	1515	
	3	Hybrid	1524	
	4	Hybrid	2213	
	5	Hybrid	1519	
	6	Hybrid	sc-1529	
Los Angeles				Madera sandy loam
	1	Trebi	c–936	
	2	Hybrid	1516	
	3	Tenn. Winter	c–2271	Planted January 16,
	4	Hybrid	1513	Harvested June 22
	5	Hybrid	1519	
	6	Tenn. Winter	c–2274	

All seed from the 1922 tests will be seeded in the same manner again next year, in an attempt to check the order of yield. The hybrids and selections were made and supplied by the Agronomy Division of the College of Agriculture.

Other Demonstration Work With Barley.—On a total of 404 farms, which represented 32,921 acres, the farm advisor's advice was taken on the introduction or improvement of the practice of barley culture. This advice was largely concerned with the planting of recommended varieties, better cultural methods, and the treatment of seed for disease control.

OATS.—California does not produce a large acreage of oats, only 146,889 acres (1920 census) out of a total of 2,656,492 acres of all cereals; consequently this crop has assumed relatively little importance in the demonstration of varieties or cultural practices relative thereto. On 61 farms, however, representing 936 acres, farm advisors reported that oat growing was introduced or farm practice relative to oat culture improved by their recommendations.

Variety Tests.—In two counties an effort was made to test out a series of new varieties which are better adapted to local conditions, are disease-resistant, and give greater yields than the Texas Red oats, which is the common variety grown. These tests were made in Humboldt and Los Angeles counties. The following table represents the order of preference in the two counties:

County	Variety	Identification number	Remarks
Humboldt			
	Abyssinian	303–a	Yield 991 lbs. per acre
	Danish		Yield 856 lbs. per acre
	Banner		Yield 772 lbs. per acre
	Richland	320–a	Yield 756 lbs. per acre
	Sparrowbill	c–1030	Yield 668 lbs. per acre
	White Tartarian	174–a	Yield 403 lbs. per acre
Los Angeles			Yolo sandy loam, planted March 2, harvested June 19
	Fulghum	257-a	Medium resistance to stem rust—early
	Kanota	Kan. 5157	Medium resistance to stem rust—early
	Burt	175–a	Slight resistance to rust—early
	Richland	320–a	Slight resistance to stem rust—early
	Abyssinian	303–a	Slight resistance to stem rust—early
	Tartar	c–1030	Slight resistance to stem rust—late

These varieties represent the best yields and characteristics of 18 selections supplied the farm advisors by the Agronomy Division of the College of Agriculture. They were planted by the rod-row method and will be tested again next year. All of the new varieties proved superior to the check of Texas Red oats.

BEANS.—Comparatively little work has been done during the year in bean improvement work, largely because the industry is an old one

in the State and has become centralized in a few of the south coast counties in southern California and to a limited degree in the interior valleys. The main problems of the industry seem to center around pest control and seed selection.

Pest Control.—In San Bernardino County work was done, in an experimental way, in coöperation with the Bureau of Entomology of the U. S. Department of Agriculture, to determine a satisfactory method of weavil control. Trap rows were established with three coöperators, which were visited weekly during the growing season. Owing to the long season, which permitted several broods to hatch,

Fig. 139.—A potato growers' field day in Los Angeles County.

this was found to be an ineffective method of control. A survey of the bean-growing district in November 1922, including warehouses, disclosed a general infestation. A district clean-up campaign has been launched in the hope that it may lessen the general infestation.

In Stanislaus County the red spider on blackeyes, coupled with hot spells in July and September, 1922, cut the yield to 50 per cent normal. Efforts are being made to established a campaign to control this pest by proper spraying methods.

New Varieties.—Limited attempts, notably in Kings County, have been made to introduce a new Chinese bean commonly named Mung bean. Several one-quarter acre plots and one 15-acre field were planted in this variety. It proved to be vigorous growing and a heavy producing plant. The bean seed itself is useful to some extent for human and poultry food. Its chief value, however, is its

use as hay, ensilage, and a green manure crop. It is for this latter reason that interest has been manifested in its introduction. Further test plots are being tried in 1923.

POTATOES.—The projects on potato improvement cover the problems of pest and disease control, variety tests, seed preparation, curing, and grading. These projects, on which progress reports have been filed, applied to Los Angeles, Kern, Alameda, Nevada, Lassen, San Joaquin, and Orange counties.

Disease and Pest Control.—Projects covered tests in the control of scab and rhizoctonia, ell-worm or common nematode control. The

Fig. 140.—The automobiles at a walnut growers' field day, Los Angeles County.

measures used in control of the first two diseases have been thoroughly worked out, which makes the problem one calling for educational campaigns. Such a campaign has been conducted in Alameda County for the past two years, with the result that a large percentage of the growers now treat their seed and are selling their entire output for seed potatoes. In Kern County five farmers were advised regarding the control of scab and rhizoctonia with the result that eight other farms, representing 120 acres, now follow the practice.

Nematode.—The control of the nematode, which is a constant menace to potato-growing districts of the State, has not been thoroughly determined and, consequently, it has been necessary to survey the regions infested and conduct a general educational campaign calling attention to the seriousness of the problem. The Potato

Growers' Department of the Los Angeles County Farm Bureau, coöperating with the Extension Service, has, as the result of last year's work, brought the problem to the attention of the majority of potato growers of the county. Some investigational work has also been done in San Joaquin County.

Seed Selection.—In Alameda County a test on the selection of seed and the methods of cutting seed for planting was tried with the following results:

Treatment, variety	Number rows planted	Average production in pounds per row	Pounds, large potatoes	Pounds, medium potatoes	Pounds, small potatoes	Pounds, culls
Large-cut seed Burbank Hill Selected	3	479.7	166.5	187.5	82.5	43.2
Medium-cut seed Burbank Hill Selected	7	443.3	121.5	223.8	88.75	9.2
Small whole seed Burbank Hill Selected	2	427.5	75	187.5	93.75	71.2
Home-grown seed Burbank Hill Unselected	2	292.5	75	150.3	55.5	11.7

The table above indicates that large-cut and medium-cut hill selected seed gave a better yield in this county than the small whole selected or home-grown unselected. They were all planted on May 1, 1922, and harvested on August 22, 1922. Results in Orange County also indicate that selected, certified White Rose seed gave an increased yield of 71 sacks per acre, producing uniform, clean and smooth potatoes over unselected White Rose, which produced uneven sizes.

Crop Introduction.—In Nevada County an attempt was made to introduce potato culture as a cash crop in those sections where new orchards are being planted. Two coöperators, after testing several varieties, showed that the Gold Coin and American Wonder are the varieties best adapted to the conditions in the county and will under ordinary conditions produce profitably. In Lassen County a similar trial was conducted to determine the best variety adapted to the county, with the result that two coöperators showed that Netted Gem and British Queen varieties outyielded Blue Centennial by two and one tons per acre respectively. Shasta County has demonstrated in three mountain centers that Netted Gem, Burbank, Early Rose, and American Wonder, preferred in the order named, are the best varieties adapted to these districts.

Cold Storage Seed.—In Los Angeles, after one year's observation, it has been found that cold-storage-cured seed for the fall crop gave better yields than untreated seed. The following table shows the comparative yields as reported by the farm advisor.

Planted August 25, 1922–Harvested December 27, 1922 at Van Nuys in San Fernando Valley

	Yield in sacks for plot. 110-pound sacks	Yield per acre in pounds	Per cent increase over untreated seed
*Plot 1–1.17 acres, spring crop seed, 1922, untreated	42 2/5 sacks	3980	....
*Plot 2 .09 acre spring crop seed, 1922, cold-storaged for two months	4½ sacks	5500	38%
*Plot 3 .09 acre, fall crop seed, 1921, cold-storaged for seven months	5¼ sacks	6416	61%

* All plots received an application of gypsum at the rate of 1000 lbs. per acre.

Grading.—The farm advisor reports that 90 per cent of the potato crop in Los Angeles County will be sold under the U. S. Bureau of Markets' grades as the result of an educational campaign which was conducted by the Extension Service through the Potato Growers' Department of the Farm Bureau.

Alfalfa.—Alfalfa growing was introduced or farm practice relative to alfalfa culture improved on 363 farms in the State, involving 10,303 acres. This acreage is a 42 per cent increase over that reported in 1921.

Seven counties, namely, Glenn, Kern, San Bernardino, Shasta, Stanislaus, Ventura, and Yuba reported specific work on alfalfa by way of demonstrations involving crop rotations, variety tests and increase of hay yields.

Corn.—The total number of farms on which corn growing was introduced or farm practice relative to corn culture improved was 32, involving 415 acres. Seventy-seven farmers planted selected seed corn and 37 farmers selected a total of 322 bushels of seed corn to plant next year.

In Mendocino and Marin Counties 31 coöperators used a variety known as Wisconsin Number Twelve, or Golden Glow. The seed was obtained from Oregon. In the tests in Marin County, Wisconsin Number Twelve was found to yield 25 per cent more corn than did the varieties commonly grown there, and in Mendocino County it yielded 12 bushels of shelled corn in tests in which the common varieties failed entirely. An added advantage when grown for silage was found in Wisconsin Number Twelve in that the growers began filling their silos with it on September 15, whereas silo filling with the common varieties was not begun until after October 1.

Corn Clubs.—Seven corn clubs were conducted, one in Inyo County and six in the coast counties. Thirty-nine boys and girls

were enrolled and 20 completed their work and reported an average production of 58 bushels of corn per acre and a total cost of $643.96, leaving a value above costs of $443.58. All of those reporting had tested their seed corn before planting and 19 selected seed for next year.

The Inyo County corn club, consisting of 16 members, has completed its second year and has conducted a convincing demonstration in the value of using better seed, selecting seed from year to year, and preparing proper seed beds.

The following table illustrates this:

	1920	1921	1922
Average yield per acre	Inyo County 28 bu. (U. S. Census Report)	Club Members 50 bu.	Club Members 71.8 bu.
Value of corn per acre	$26.32 (1921 prices)	$47.00 (1921 prices)	$74.40 (1922 prices)
Cost of production per acre	$28.75 (1921 prices)	$28.75 (1921 prices)	$47.34 (1922 prices)
Profit per acre	$1.43 Loss	$18.25	$27.06

Grain Sorghums.—The number of farms on which sorghums, dwarf milo, or feterita growing was introduced or farm practice relative to their culture improved was 391 and these involved 3980 acres. This is a 60 per cent increase over the number of farms reported last year.

Every one of the grain sorghum demonstrations by means of tests (134 in all) involved comparisons of Yolo maize with Dwarf Milo, Egyptian corn, or Feterita. Yolo maize is a natural hybrid, carefully selected for a number of years by the Division of Agronomy at the University Farm, which produces uniformly upright heads and, therefore, lends itself to machine harvesting. Many of the demonstration fields of Yolo maize had not been harvested at the time the farm advisors made their reports, so definite comparisons of yields could not be obtained. The few yields reported tend to show that Yolo maize yielded slightly less than Dwarf Milo and about the same as Egyptian corn. Experience with growing Yolo maize has shown that in general it has shown itself to be more drouth resistant than Dwarf Milo, and that it matures from one to two weeks later, or longer if an abundance of irrigation water is supplied. Because of the requirement of a longer time to mature a crop of Yolo maize it is believed to be unsuited for use as a second crop. In fact, in tests in Tulare County it failed to mature at all when planted after June 5.

Grain Sorghum Clubs.—Five clubs with a total enrollment of 32 boys were organized, and 17 boys reported. There were 912.2 bushels of grain sorghums produced by these 17 boys at a cost of \$782.43. The value of their crop was \$1463.49 and their profits were \$681.06. Most of these boys were growing Yolo maize and those producing it for seed are known to have carefully rogued their fields and prepared a high quality product.

FORAGE CROPS.—The growing of such clovers as sweet, red, alsike, or white clover was introduced or farm practice relative to the growing of these clovers improved on 337 farms on a total of 3350.5 acres.

Purple Vetch with oats for hay was thoroughly tried out in the Sierra foothills section of the Sacramento Valley. In tests, either with or without irrigation, the yields showed increases varying from 50 per cent to 100 per cent over the oat hay crop when grown alone. Since very little if any alfalfa is grown in the regions where these tests were made, an added advantage was found in this hay in that it supplied a leguminous feed.

Sudan Grass for pasture was grown in 14 demonstration tests in four counties, namely, Shasta, Lassen, Tehama, and Fresno, and was found to produce abundant pasture—even under such dry and unfavorable conditions in Lassen County that alfalfa failed entirely.

Rhodes Grass grown for hay in Kings and Madera counties produced two good cuttings, and was found to be noticeably resistant to alkali in tests of its resistance in highly impregnated soils.

Sunflowers were grown for silage in nine demonstrations in three widely separated counties of the State, namely, Lassen, Mendocino and San Benito. Yields varying from 10 tons per acre in Mendocino County up to 54 tons per acre in Lassen County are reported and the ensilage is being fed with good results. One farm advisor calls attention to the fact that sunflowers are free from smut, whereas corn smut in silage corn is a serious problem in his county.

COTTON.—Cotton growing was introduced or farm practice relative to the growing of cotton improved on 2 farms involving 339 acres. Cotton was grown in demonstration tests in Butte and Yuba counties to determine its value as a cash crop in certain grain growing areas. The results of the tests were reported as satisfactory and further tests will be made.

SUGAR BEETS.—The growing of sugar beets or practice relative thereto was influenced on 11 farms involving 21 acres. In addition to this Alameda County reports pest control work covering 1000 acres in cooperation with representatives of the U. S. Department of Agriculture. Year after year in Ventura County the yield of sugar

beets is declining and extensive work is being done in the promotion of crop rotation and the introduction of livestock, the manure to be used to increase the yield of beets.

In Lassen County two beet-growing demonstration tests were made and yields of from 15 to 18 tons per acre were obtained. These yields tend to show that mangel beets can be grown in Lassen County to produce a supplementary winter feed for stock.

VEGETABLE GROWING.—A vegetable growers' department of the county farm bureau has been organized in Ventura County during 1922 and is now operating.

In Imperial County demonstrations by means of tests are concerned in the growing of eight varieties of tomatoes, and six demonstrations involving 14 varieties of peas are being conducted. The tests at the time of reporting were incomplete.

Tomato growing was introduced or practices relative to the culture of tomatoes improved on 76 farms involving 1035 acres.

Mixed Vegetable Clubs.—There were 24 garden clubs conducted, with 202 members enrolled. The total estimated value of the vegetables produced by the 117 members who reported was $3,628.27, the costs $1,457.95, and the estimated value above costs $2,170.32. The enrollment in 1922 was a 21 per cent increase over last year's number.

SMALL FRUIT GROWING.—In Kern County a test including 12 different varieties of strawberries planted in 1921 has completed its second year. Close observations are being made regarding the vegetative and fruiting habits of each variety, and to date the Ettersburg No. 80, from a market standpoint, has proved to be the best.

Following an analysis of the agriculture of the Prunedale district in Monterey County the Farm Bureau Center adopted a project for the promotion of berry growing in the lower and richer soils. As a result 10 acres of bush fruits have already been planted, and the project will be continued.

The farm advisors report having assisted in the introduction of or the improvement of cultural practices of small fruits on 183 farms involving 523 acres.

Strawberry Clubs.—Three strawberry clubs were conducted in Sacramento County and one in the Paradise district of Butte County. Twenty-six boys and girls were enrolled and 16 of them reported a profit of $61.35.

SEED PRODUCTION AND MARKETING.—Improved seed was offered for sale from 88 farms in 12 counties, including 27,329 bushels of wheat, barley, certified seed potatoes, Milo, Dwarf Milo, Yolo maize, and corn.

Purple Vetch Seed.—The second year of purple vetch seed production tests in Santa Barbara County, including 13 tests, has been concluded. Yields from seven of these tests were obtained, varying from 200 lbs. up to 800 lbs. of recleaned seed. Observations showed that the best yields were obtained from the lighter types of alluvial soils and where sown relatively early and at relatively heavy rate of seeding.

Lima Bean Seed.—The Ventura farm advisor reports great interest in a five-year project as outlined in that county for the selection of high-producing strains of lima beans. Nineteen coöperators made selections from outstanding plants in 1922, and one of these, who began earlier to make selections, reports from one selected strain a 200 lbs. per acre increase over his field run of lima beans.

Seed Purchasing.—Farm advisors in 26 counties reported purchases of improved seed by 621 farms, involving a total of 32,143⅓ bushels. Many of these purchases were handled through the county farm bureau exchanges or otherwise handled coöperatively. A saving of $1700 on one purchase of improved alfalfa seed is reported from the work of a farm bureau center committee in Ventura County. In San Bernardino County a carload of Texas Red oats was purchased at a saving of $210, and 3000 lbs. of alfalfa seed was purchased at a saving of $64. No doubt many larger savings were made in seed purchases, but the amounts are not reported.

ORCHARD AND VINEYARD CROPS

Orchard Planting.—Large losses occur each year in California, due to the lack of knowledge of how to plant trees, and often from the lack of application of facts that are well known. The object of this project is to demonstrate the best known methods of planting and make comparisons of good and bad practices. In order to make these comparisons trees were planted as correctly as possible, and other trees were planted by subjecting them to various supposedly improper conditions, such as planting too deeply, roots pruned and unpruned, roots dried out and those not dried, using protectors of various kinds, whitewashed and bare trees, and mature and immature trees. Twenty-four demonstrations have been held with 419 persons attending. It is difficult to express the results of this type of work in figures, but the advisors in the field believe that it is well worth while and is responsible for a very considerable saving to the growers. In Contra Costa County "four orchardists representing 130 acres of apricots were assisted in their planting. Particular emphasis was

placed on proper preparation of soil, minimum exposure of trees, proper root and top pruning, and adequate tamping. In these orchards a 95 per cent stand was obtained.''

Grafting and Budding.—The work in grafting and budding was done in 11 counties, in which 26 demonstrations were held with an attendance of 979 persons. The major part of this work was demonstration of methods of budding and grafting. It has been of great value because many growers have trees that did not come true to name and also trees of poor varieties which they wished to work over to profitable varieties. A great deal of work has been done in grafting individual trees and border rows of black walnuts over to English walnut varieties. Considerable top-working of old apple and pear trees to standard commercial varieties has been done. In the foothill sections, where many old and unknown varieties exist, the work has been carried on with very beneficial results. The question of bud selection is becoming more and more important, and this has given a great impetus to top-working old trees, and also to the budding and grafting of nursery stock to selected buds and grafts of new and improved varieties. The realization of the benefits of cross pollination for many varieties of fruit has led to a very material increase in this work, and the many and varied problems found in this connection have been responsible for interest in this project. Growers generally seem always interested in budding and grafting, and most of them get some profit and always much pleasure from this work.

Tree Wiring.—Tree wiring demonstrations were held in 12 counties. Fifty-four demonstrations were held with 820 persons attending. The method demonstrated is the one recommended in Circular 244 of the College of Agriculture, which is proving very satisfactory. Now that the so-called ''long pruning'' is being more generally used the trees are carrying more fruit, and because of this growth on trees pruned by this method it becomes doubly important that the branches be given support in order to carry this additional load. Wiring is proving much more efficient and less expensive than propping. In a few cases growers had some breakage of limbs because the wires were not properly placed, being either too high or too low. This fault, however, has not been general. Hundreds of acres of trees have been wired.

Tree Surgery and Rejuvenation.—This work was carried on in eight counties. The surgery was used in rather specific cases, such as cutting-out of pear blight, crown gall, and the cleaning out of decayed areas due to wound fungi affecting the trunks and larger

limbs. Surgery is the best and only effective means now known to control pear blight, and where the work is done carefully and with thorough understanding of a few fundamental principles is proving satisfactory. A great deal of work has been done in the control of crown gall by cutting out the diseased galls. Where the disease has not progressed too far, and where this work is done carefully, disinfecting the wounds and painting them over with a good tree paint is proving a very promising control measure for this disease. The last word in this control measure, however, has not yet been said.

In Sonoma and Shasta counties some very good rejuvenation work has been done in treating wounds by digging out the dead area and treating them with tree paints and concrete filling. Many of these trees are in poor condition from lack of care or improper care, and have become badly sunburned. There is often much dead and moss-covered wood in them. To improve this condition a good pruning is given, followed by a good clean-up spray. The work so far is exceedingly encouraging, and will be followed to improve methods and to cut down costs of operation.

Orchard Management Clubs.—Twenty boys of high school age were enrolled in orchard management clubs in Los Angeles and Fresno counties, 14 of whom finished the project. These boys took one or more acres, mostly more, of orchard, and carried on the orchard practices in a commercial way and kept accurate accounts of their operations. They took an inventory at the beginning and at the close of the year. The three clubs produced products valued at \$7053.36 with a profit of \$2210.06. There were 121 acres involved, of which 112 acres were long-pruned. From these clubs the spread of influence reached eight farms representing 320 acres.

Deciduous Long-Pruning.—Deciduous tree pruning during the last year was carried on in 33 counties in the State. There were 4763 farms involved representing 70,266 acres of trees. Three hundred ten meetings were held at pruning demonstrations with 11,129 persons present. During the past year the farm advisors carried on 110 pruning tests with 27 varieties of fruit on 27 different and distinct soil types upon which comparative results were obtained and tabulated. Many of these tests were duplicated on the same soil type, and many of the varieties were duplicated on the same soil and also on different soil types. The test plots have varied in size from two trees up to as much as 20 acres. The most common and generally used units were plots of 10 to 20 trees. These tests have been conducted with the idea of demonstrating the best method of pruning deciduous trees in the various parts of California.

RESULTS OF TESTS ON PRUNING DECIDUOUS TREES FROM FARM ADVISORS IN CALIFORNIA—1922

County	Variety fruit	Age	Soil type	How pruned	Number of trees	Average per tree	Yield per plot	Tree growth	Quality of fruit 1 2 3	Fruit thinned properly Yes No	Number of irri- gations	Coöp- erator
Butte	French Prunes	4	Vina Clay Loma	Long Short	3 10 A.			Av. Cir. 8.78 in. 3 ft. higher Av. Cir. 6.46				J. A. M.
	Bartlett Pear	8	Columbia fine sandy loam	Long Short	6 A. 31 A.	5.83 Bxs. 3.7 Bxs.		Better fruit wood	No difference			C. S.
	French Prunes	5	Aiken loam	Long Short	3 Bal. of orchard			15% larger growth, 20% better top				A. R.
	Tuscans	4	Madera and Gridley clay loam	Long	3 A.		6 tons per A.	Ideally pruned	All			A. J. M.
	Plums	3	Columbia fine sandy loam	Long	1 row			Better shaped, better trees				J. F. H.

Fresno	Apricots	3	San Joaquin sandy loam	Long Medium Short	6 6 6			Diameter Terminal Growth 3 in. 36–40 in. 2 2/3 in. 36–40 in. 2 5/6 in. 48–60 in.			3	M H C
	Peaches		San Joaquin sandy loam	Long Medium Short	4 4 4			2.41 in. 24–30 in. 2.23 in. 24–30 in. 2.22 in. 36–38 in.				R F G
	Peaches		Fresno sandy loam	Long Medium Short	6 6 6	214 193 179	11.57 T. 10.42 T. 9.66 T.			Yes		G.F.
	Nectarines		Fresno sandy loam	Long Medium Short	4 4 4	199 198 101	10.74 T. 10.69 T. 5.45 T.					L.M.M
	Peaches	8-9	Oakley and Fresno sandy loam	Long Medium Short	254 (1921) 254 (1922) 254 (1920)	½ long all long	6 T. 19 T. 375 lbs. 0 T.					W.R.S
Kern	Santa Rosa Plums	2	Hanford sandy loam	Long Short	12 12		75 lbs. 25 lbs.	Est. 20% better than short		Yes		L.D
	Alexander Apples	9	Hanford sandy loam	Long Short	15 15		1500 lbs. 375 lbs.	Est. 25% better than short		Yes		L.D
	Peaches	2	Madera sandy loam	Long Short	5 5		11.5 lbs. 0	Est. 25% better than short		Yes		J.J.
	Jonathan Apples	7	Gravelly loam	Long Short	5 5			Results not yet reported				L.J.K.
	Bartlett pears	7	Gravelly loam	Long Short	5 5		4.1	Results not yet reported				L.J.K.
	Apples	3	Gravelly loam	Long Short	20 20		4.1 lbs. 0			Yes		W.P.

Results of Tests on Pruning Deciduous Trees from Farm Advisors in California—1922 (*Continued*)

County	Variety Fruit	Age	Soil type	How pruned	Number of trees	Average per acre	Yield per plot	Tree growth	Quality of fruit 1 2 3	Fruit thinned properly Yes No	Number of irri-gations	Coöp-erator
Kings	Tuscan	4	Hanford sandy loam	Long Short	5 5		147 lbs. 18 lbs.	15% to 20% better than short		No	Sub-Irrigated	G.A.
	Tuscan	4	Hanford sandy loam	Long Short	5 3		231 lbs. 42 lbs.			Yes	Sub-Irrigated	W.H.L.
	Elberta	3	Hanford sandy loam	Long Short	3 3		31.5 lbs. 5 lbs.	20% better than short		Yes	Sub-Irrigated	N.M.
	Tuscan	4	Hanford sandy loam	Long Short	3 3		105 lbs. 12 lbs.	10% better than short		Yes	Sub-Irrigated	G.H.
	Tuscan	2	Hanford sandy loam	Long Short	3 3	Non-bearing		10% better than short			Sub-Irrigated	R.G.H.

Los Angeles	Royal Apricots	8	Hanford sandy loam	Long Short	2 1	275 lbs. 240 lbs.		20% better than short	95 80	5 10	 5	Yes	2	W. P.
	Royal Apricots	10	Hanford sandy loam	Long Short	5 2	350 lbs. 200 lbs.		30% better than short	95 96	5 4		Yes	1	A. H. C.
	Peaches	3	Hanford sandy loam, coarse, some gravel	Long Short	2 2	50 lbs. 4 lbs.		40% better than short	97 95	2 3	1 2	Yes	Dry Farmed	K. B.
	Plums	3	Hanford sandy loam, coarse, some gravel	Long Short	2 2	35 lbs. 3 lbs.		40% better than short	97 95	2	1 5	Yes	Dry Farmed	K. B.
	Peaches	2	Hanford sandy loam	Long Short	3 3	9½ lbs. .25 lbs.		30% better than short	97 100	3		Yes	3	W. J. W.
	Peaches	9		Long Short	8-1 yr., 9-2 yr. 8 always	199 lbs. 228 lbs. 168 lbs.		20% better than short	98 80	1 5	1 15	Yes	3	C. G.

RESULTS OF TESTS ON PRUNING DECIDUOUS TREES FROM FARM ADVISORS IN CALIFORNIA—1922 (*Continued*)

County	Variety fruit	Age	Soil type	How pruned	Number of trees	Average per tree	Yield per plot	Tree growth	Quality of fruit 1 2 3	Fruit thinned properly Yes No	Number of irri-gations	Coöp-erator
Madera	Tilton Apricots	7	Madera sandy loam	Long Short	276 276		Approx. 26 T. fr.	No difference except in type	Good—no difference		3	C.H.K.
	Muir Peaches	5	Hanford sandy loam	Long Short	40 A. 3		18 T.	No difference except in type	Good—no difference		3	C.G.B.
	Tuscan Peaches	7	Madera sandy loam	Long Short	3¾A. (1922) 3¾A (1920) (1921)		16 T. 5 T. Frost		14½ T. 1½ T.		3	C.O.
	Elberta	4	Madera sandy loam	Long Short	3 3	Frost		53% gain in circum. 28% gain in circum.			4	P.H.
	Tilton Apricots	2	Hanford sandy loam	Long Short	4 4			73% gain in diameter 57% gain in diameter			3	M.M.

Merced	Almond IXL Non Pareil Ne Plus Texas	3	Madera loam	Long Short	10 10		5 8 lbs. 0	30% better than short			1	C.H.B.
	Royal Apricots	3	Madera silt loam	Long Medium Short	150 150 50			10% better than medium 30% better than short				C.P.C.
	Blenheim Tiltons	3	Madera silt loam	Long Short	10 10			30% better than short			2	M.R.
	Salways Phillips Tuscans	3	Madera silt loam	Long Medium Short	500 500 275		1000 lbs. per 1000 lbs. per	A 10% better than medium A 30% better than short	Poor	No	1	C.P.C.
	Elberta	4	Madera sand	Long Short	10 10	31 0		50% better than short	Very good	No	2	P.
	Tuscan	4	Madera sand	Long Short	10 10	28 lbs. 0		50% better than short	Very good	Yes	4	M.A.W.
	Blenheim	4	Madera sand	Long Short	10 10	35 lbs. 0		20% better than short	Very good	No	4	M.A.W.
	Elberta Muir	5	Madera sand	Long	28 A.		8 T. Elbertas 6½ T. Muir			Muir Yes Elberta No	2	M.P.S.
	Elberta	5	Madera sand	Long Short	8 A. Aband.		13 3/8 T.			Yes	2	C.A.L.
	Elberta	2	Madera loam	Long Short	10 10			10% better than short			2	J.F.N.

RESULTS OF TESTS ON PRUNING DECIDUOUS TREES FROM FARM ADVISORS IN CALIFORNIA—1922 (*Continued*)

County	Variety Fruit	Age	Soil type	How pruned	Number of trees	Average per acre	Yield per plot	Tree growth	Quality of fruit 1 2 3	Fruit thinned properly Yes No	Number of irri-gations	Coöp-erator
Napa	Pear	2	Residual silt loam	Long Short	5 A.						6	R.I.
	Pear	2	Residual silt loam	Long Short	25 A. 5 A.			5% better than short				J.H.B.
	Pear	8	Clay loam residual	Long Short	10 10	300 lbs. 318 lbs.			90 5 5 84 16	Yes		G.S.
	Pear	12	Clay loam residual	Long Short	10 10	1300 lbs. 1050 lbs.			60 40 66 33	Yes		G.S.
	Pear	30	Clay loam residual	Long Short	20 20		2825 lbs. 4400 lbs.	35.9% better than short		Yes		A.M.
	Pear	8	Clay loam residual	Long	85		4 T.		85 15	Yes	2	G.W.
	Pear	18	Clay residual	Long	1 A.		5850 lbs.		50 50	Yes	Lack moist.	S.H.W.
	Pear	7	Clay residual	Long	3 A.		8 T.		90 10	Yes		G.H.L.
	Pear	8	Clay loam residual	Long Short	10 10			10% better than short		Yes		D.A.D.
	Pear	7	Clay loam residual	Long	50		2¼ T.		85 15	Yes		M.

Nevada	Bartlett Pear	8	Aiken clay loam	Long Short	5 5		1378 lbs. 622 lbs.	20% better than short	85 7.5 7.5 100			O.F.W.
	Bartlett pear	2	Aiken clay loam	Long Short	5 5			About same				P.M.B.
	Bartlett Pear	8	Aiken clay loam	Long Short	5 5	Yield not recorded acct. of blight. Est. 50% more on long than short		10% better than short	Long good as short	Yes	2	P.B.
	Bartlett Pear	25		Long Short	3-1 dead 4	168.3 lbs. 139.5 lbs.		Little difference	About same			C.F.M.
	Mixed Peaches		Shallow Sierra clay	Medium Short	55 4	4.89 lbs. 2.66 lbs.		Too thick Desirable growth	About same		4	H.W.

RESULTS OF TESTS ON PRUNING DECIDUOUS TREES FROM FARM ADVISORS IN CALIFORNIA—1922 (*Continued*)

County	Variety fruit	Age	Soil type	How pruned	Number of trees	Average per tree	Yield per plot	Tree growth	Quality of fruit 1 2 3	Fruit thinned properly Yes No	Number of irri-gations	Coöp-erator
Placer	Grand Duke	4	Decomposed granite	Long Medium	17 18	None		20% better than medium				H.E.B.
	Duarte	4	Decomposed granite	Long Medium	9 8	None		17% better than medium				H.E.B.
	J. H. Hale	4	Decomposed granite	Long Medium	12 13			About same				H.E.B.
	Levi Cling	5	Decomposed granite	Long Medium	10 10	No record		10% better than medium		Yes		H.E.B.
	Bartlett Pear	4	Decomposed granite	Long Medium	5 7			5% better than medium				J.E.B.
	Peaches Varieties	3	Decomposed granite	Long Medium	5 5			10% less than medium				J.E.B.
	Bartlett Pears	5	Slate	Long Medium	5 5			5% better than medium				E.A.F.
	Bartlett Pears	3	Slate	Long Medium	5 5			About same				E.A.F.

Sacramento	Bartlett Pears	6	Stockton clay adobe	Long Short	1 1	250 fruits 20 fruits			99 100		3	C.J.J.
San Benito	Blenheim Apricots	6	Black adobe	Long Short	4 4	Frosted		1.3 in. circum. over short Both increased 4 ft. in height			1	B.W.J.
San Diego	Royal Apricots	4	Sierra sandy loam	Long Short	7 8	9½ lbs. 8 lbs.		12½% better than short	All	No		W.F.G.
	Elberta	3	Placentia loam	Long Short	2 2		100 lbs. 62 lbs.	10% better than short	Good	Yes	2	J.B.S.
	Tuscan	1										L.W.
	Phillips	4	Sierra sandy loam	Long Short	3 3	45 lbs. 7 lbs.		10% greater diam. growth 50% greater length	All A1	Yes		J.B.R.
	2 Salway 1 Susquehanna	5	Foster sandy loam	Long Medium Short	1 1 1	165 lbs. 130 lbs. 70 lbs.		25% greater	25% Bal. 25% Bal. 100%	Yes		A.W.J.

RESULTS OF TESTS ON PRUNING DECIDUOUS TREES FROM FARM ADVISORS IN CALIFORNIA—1922 (*Continued*)

County	Variety Fruit	Age	Soil type	How pruned	Number of trees	Average per acre	Yield per plot	Tree growth	Quality of fruit 1 2 3	Fruit thinned properly Yes No	Number of irri-gations	Coöp-erator
San Joaquin	Bartlett Pears	8	Peat	Long	5			Satisfactory			High water table	J.A.A.
	Bartlett Pears	2	Peat	Long Short	4 4			Est. 10% better than short	All good		High water table	J.A.A.
	Elberta	8	Hanford fine sandy loam	Long Short	4 4	68 lbs. 44½ lbs.		Trunks 2% better than short			2	A.R.P.
	Hungarian Prune	4	Hanford fine sandy loam	Long Short	6 6			8% better growth			1	L.K.M.
	Phillips	4	Honcut loam	Long Short	20 A. 1 tree	178 lbs. 44 lbs.		Rank on all-better controlled on long	All A1		2	R.M.
	Giant Prunes	8	Hanford fine sandy loam	Long Short	5 5	Lack of polli No fruit	nation	Rank on all-better controlled on long			1	J.V.B.
	Tragedy Prunes	2	Hanford fine sandy loam	Long Short	5 5			Rank on headed back trees, more controlled on long			1	J.V.B.
	Sugar Prunes	2	Stanislaus river bottom	Long Short	5 5			Trunks 15% larger than short			Over-flow	P.F.B.

Santa Barbara	Royal Apricots	3	Old alluvial	Long Short	5 5	¼ Bxs. ¼ Bxs.		No difference				
	Royal Apricots	3	Recent alluvial	Long Medium	5 5	¼ Bxs. 1 Bxs.		No difference			2	
Santa Cruz	Spitzenberg Bellflower Jonathan W. Banana Delicious Newtown Spitzenberg Bellflower	1 1 1 1 1 1 1 1	Altamont loam	Long Long Long Long Long Long Short Short	8 3 9 5 6 17 152 47	Too young		10% over short				
	Royal Apricot	4	Altamont loam	Long Short	120 20	Too light		15% over short				
	Bartlett Pears	3	Altamont sandy loam	Long Short	297 3			No difference				
Solano	Apricots	5	Recent alluvial	Long Short				41% 61%				C.M.
	Apricots	5	Recent alluvial	Long Short				11% 13%				J.R.C.
	Apricots	2	Recent alluvial	Long Short				166% 155%				J.R.C.
	Bartlett Pears	5	Recent alluvial	Long Short				52% 45%				C.M.R.
	Apricots	3	Recent alluvial	Long Short		27.5 1.16				No	0	J.R.C.
	Apricots	5	Recent alluvial	Long Short		50. 40				No	0	C.M.

RESULTS OF TESTS ON PRUNING DECIDUOUS TREES FROM FARM ADVISORS IN CALIFORNIA—1922 (*Continued*)

County	Variety fruit	Age	Soil type	How pruned	Number of trees	Average per tree	Yield per plot	Tree growth	Quality of fruit 1	2	3	Fruit thinned properly Yes No	Number of irri-gations	Coöp-erator
Sonoma	Bartlett Pears	25	Aiken clay loam	Long Short	1 1		9 T. per A. 6¼ T. per A.	Fair	60	20	20	No	No	F.L.
	Bartlett Pears	6	Yolo loam	Long Short	1 1	161 lbs. 55 lbs.		Fair Large				Yes	0	G.P.D.
Stanislaus	Phillips Cling	7	Fresno sandy loam	Long Short	5 5		82 Bxs. 19 Bxs.		90 95	10 5		Yes Yes	3 3	C.N.S.
	Muir	3	Fresno sand sand	Long Short	5 5		325 lbs. 75 lbs.		98 100	2		Yes	2 2	G.M.
	Blenheim Apricots	3	Fresno sandy loam	Long Short	3 3		12 Bxs. 7.5 Bxs.		89 85	11 15		No	3	F.E.B.
	Tilton Apricots		Fresno loam	Long Short	4 4		5 Bxs. 1.75 Bxs.		95 80	5 20		No	3	F.E.B.
	Tilton Apricots		Fresno sandy loam	Long Short	5 5			40% over short						C.N.W.

Sutter	Hayes Peach	3	Madera and Gridley loams	Long Short	28 406	17 lbs. 13 9 lbs.	476 5639		100 100	Yes	2	F.L.H
	Phillips	3	Madera and Gridley loams	Long Short	10 10	2 2 1	22 1		100 100	Yes		W R C
	Hayes Peach	4	Madera and Gridley loams	Long Short	10 10	14.6 20.6	146 206	Some of trees are not healthy account being planted in former corral	80 20 80 20	Yes Yes		J.E.B.
	Tuscan	10	Madera and Gridley loams	Long Short	50 48	196 164	9800 7872		88 12 92 8	Yes Yes		E S M
	Johnson	8	Madera and Gridley loams	Long Short	100 100	337 6 389.15	33755 38915	Modified system of cutting back only in tops and thinning out branches has been developed — seems quite successful.	About same for both	Yes	6 6	J.C.A.
	Tuscan	8	Madera and Gridley loams	Long Short	481 13	165.3 70.	79515 910		98 2 98 2	Yes Yes		C.C.G.
Tulare	Phillips Cling	4	Foster sandy loam	Long Short	30 313		9800 lbs. 25% 8800 lbs. 15%		90 8 2 95 3 2	Yes	2 2	C P C
	Levis	14	Madera sandy loam	Long Short	350 210		9 T. A. 20% 8 T. A. 10%		All dried	Yes	3 3	W K

Since the Division of Pomology of the College of Agriculture has recommended and published a bulletin on a method of pruning called "long-pruning," the pruning tests have been a comparison of degree and form of pruning designated as short, medium and long. The great majority of the tests have been long vs. short-pruning. In going over the tabulations and narrative reports of the farm advisors it is difficult to arrive at an exact average of yield and tree growth because of the fact of difference in size of plots, age of trees, and unit of measure used by the various men in the field. In the comparison of tree growth practically all the men report a greater

Fig. 141.—The results of long pruning, as shown on short pruned and long pruned trees in Kings County. Note the resultant yield in boxes beside each tree. Three hundred and ten meetings were held at pruning demonstrations, attended by 11,129 persons. There were 4763 farmers that reported having long pruned 70,266 acres of trees.

diameter growth on long-pruned than on short-pruned trees. As to terminal growth, a few of the men reported little or no difference, while most of them report better growth on long than short-pruned. In using the term "better," which was very generally used, it does not necessarily apply to length growth of individual shoots, but to the general development of top of the tree. In comparing yields of long and short-pruned trees, almost without exception the long-pruned trees have yielded more fruit than the short-pruned trees. Where the long-pruned trees produced about the same amount or less than the short-pruned, the cause in most cases was apparent, and was usually due to entrance of some other factor, such as disease

affecting the trees, or lack of difference between the two types of pruning.

In yields there is considerable range on the plots pruned by the two methods. In a few cases the extremes run from a slight increase to over a thousand per cent. However, in going over the figures carefully the great bulk of average will run from about 20 per cent to 70 per cent, with perhaps a safe conservative average of 35 per cent, or 40 per cent increase of long-pruned over short-pruned. Efforts were made to obtain data on quality of fruit from trees pruned by

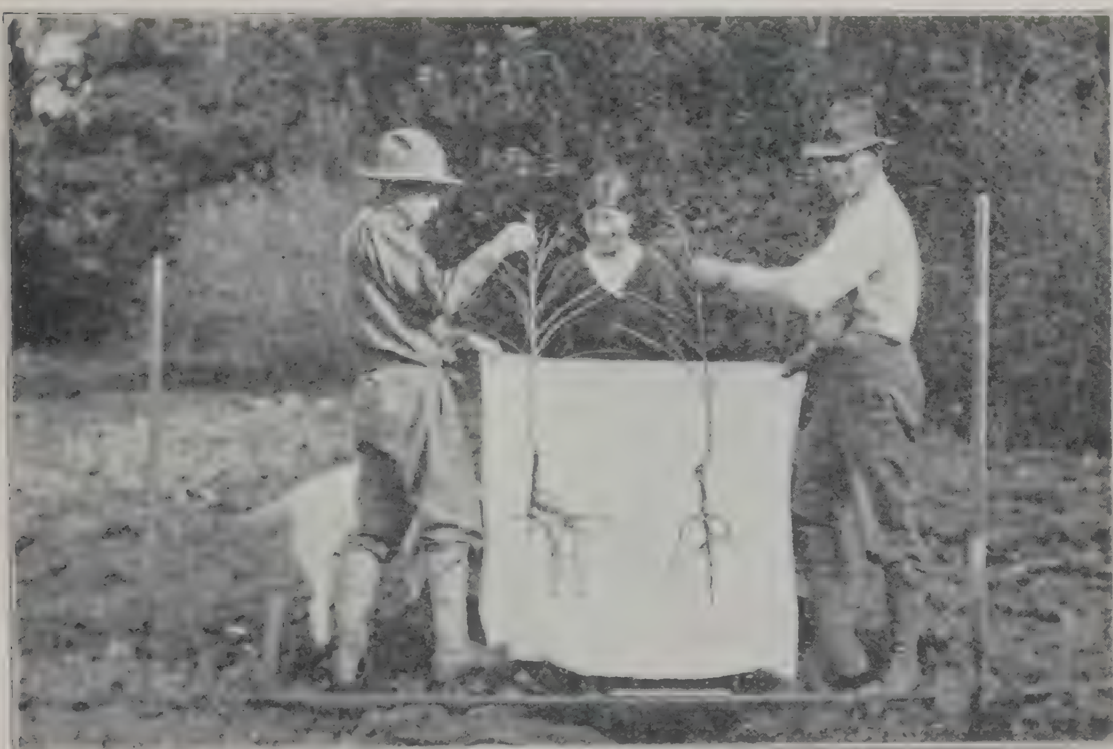


Fig. 142.—Twenty-four demonstrations have been held on tree planting, attended by 419 persons.

the two methods, and while it was not possible to get this information on all the plots yet considerable data were secured. It was found from gradings made at the canneries and by grading fruit from small numbers of trees that the quality was just as good on long-pruned as on short-pruned trees. In the report from the Peach Growers' Contest in Sutter County we find this statement, "Stress is laid on high quality and prizes are given for No. 1 fruit only, as graded by the canners." Also, "This year, the prize-winning orchard produced 24 tons, 591 pounds of No. 1 fruit per acre, while one 5-year-old orchard went 22 tons, 380 pounds to the acre, and one 3-year-old orchard produced six tons, 862 pounds per acre." —"Practically all the orchards winning cups this year were long pruned."

The criticism has been made that the quality of the fruit on long-pruned trees was not as good as on short-pruned trees. There is no doubt some truth in this statement, yet it is not due to long-pruning, but to a disregard of other factors that must be considered in connection with long-pruning. Where the work is done properly a larger amount of "No. 1" quality fruit is produced on long-pruned than on short-pruned trees. Long-pruning has not been adopted by all the growers in the State for various reasons. Many who have adopted it find there are certain difficulties that must be overcome in making such a drastic change in a long established horticultural practice. One of the most obvious of these difficulties is the labor problem. Fruit growing in California is carried on on a large scale and the former pruners have been taught the short method, and it is difficult and often slow work changing their methods. The new or transient pruners have to be taught the new method from the beginning, so that facing these two conditions there is little wonder that this method of pruning has not reached the stage of perfection where it can be applied properly over a great industry. In many cases growers who have studied the method and are attempting to put it into practice find that they get into difficulties which often cause worry and exasperation. In checking up on a large number of these cases the farm advisors have found that certain mistakes have been frequent. Because of these mistakes some growers have jumped at wrong conclusions, and until these mistakes have been rectified they are inclined to criticize the method. If pruning of any kind is to be done properly, one must have at least some understanding of the fundamentals of tree growth and then he must acquire the art or skill of putting these into a practice that is suited to his local conditions. It may also be said that one must know something of how the variety will respond under his conditions for tree growth to get the maximum results from his system of pruning. Observation of pruners in the field show that many have not yet fully grasped the "why" and others have not acquired enough skill and dexterity in doing the mechanical operation so that they can apply it accurately and speedily to the various cases that they constantly encounter. These difficulties, however, can be overcome by experience and practice.

The results of the past year's work show that certain difficulties were uniformly common. Some outstanding ones are:

(1) Many growers are inclined to leave too much fruit wood, thereby causing the operation of thinning to be expensive, or, what is worse, not taking off enough fruit, which prevents the remaining crop from sizing properly.

(2) Long-pruned trees will set more fruit than short-pruned trees, thereby necessitating more water than with the lighter crop. The importance of supplying and maintaining this additional soil moisture has not been fully appreciated, and the result has been that often the fruit has not properly sized, and in some cases the trees have actually suffered as a result of the shortage of moisture.

(3) That because of the increase in amount of crop and type of tree growth caused by long-pruning more attention must be given to the matter of bracing to prevent breakage of limbs. This problem,

Fig. 143.—The use of charts for field meetings is extensively used to emphasize the points under discussion.

however, is being well solved by the system of central wire bracing which is coming into quite general use and is proving very satisfactory.

Growers who have used the long-pruning from the time of its introduction are gradually perfecting the method to suit their conditions and are very enthusiastic about the method where this result has been accomplished. Several farm advisors report that over 75 per cent of the orchards in their counties are using the long-pruning method. Many other agents say, "Long-pruning is so generally used in my county it is difficult to get short-pruned plots to be used for comparison." In many cases difficulties occurred because of improper application of the method and in most cases the cause of the difficulty was apparent upon investigation.

An interesting point of common observation is that the pruning practically all over the State is not as severe as formally, showing that most of the growers are either consciously or unconsciously practicing "longer" pruning. California produced one of her largest fruit crops in 1922, yet the early estimates pointed to a rather light yield. Many experienced growers were deceived in their earlier estimates because the crop, which later developed into a bumper crop, was spread out and hidden by the foliage. This condition is no doubt largely attributable to the cumulative effect of long-pruning. When this system is more generally understood and the men who will do the actual pruning have become proficient in it, there will undoubtedly be very little of any other system used, if present accomplishments can be used as a criterion. Future work on this problem will be in the nature of clearing up some of the points which are now not quite clear, and perfecting and speeding up the field operations. The work of the last few years has shown very strikingly that long-pruning is no longer an experiment but an improved horticultural practice.

Vineyard Planting.—Expansion of the vineyard area continued in 1922, new plantings approaching those of 1921, which amounted to 78,000 acres, according to the statistical authorities of the State. There were conducted during 1922 by farm advisors and specialists from the Division of Viticulture, covering all phases of vineyard operation, a total of 190 field demonstrations with an attendance of 8235 persons as compared with 104 demonstrations with an attendance of 5001 in 1921. The new vineyardist has freely sought the aid of the farm advisor. The service rendered both to groups and in farm calls has had to do with preparation of the land for the young vines, including subsoiling and leveling, laying out the irrigation system, laying out the vineyard, treatment of cuttings and rootings, root pruning before planting, and depth of planting. Haste to plant raw land has spelled failure for too many vineyardists before the new vine enterprise was fairly launched. Thorough preparation of prospective vine land before planting has been the advice of the farm advisor, this counsel being based on hard experience of past years. To start the new vineyard right rather than to attempt to make over the old vineyard has been the aim throughout the entire Extension Service in the 31 counties reporting viticultural work. Chief among these counties are Fresno, Imperial, Kern, Kings, Madera, Merced, Riverside, San Joaquin, Stanislaus, and Tulare.

General Vineyard Management.—Farm advisors' activities both in conducting demonstrations of methods and of establishing demon-

strations of results have kept to the front two important factors, namely, (*a*) Improvement in quality of product, and (*b*) improvement in vineyard practice to reduce the cost per unit of product.

To secure improved quality of grapes and raisins, organic content in soil and proper and sufficient irrigation have been demonstrated as necessities. Fundamentals in management to accomplish these ends have received increased attention with the long-time project as the means of carrying on systematic work. Subsoiling, the furrow method of irrigation, and cover cropping have been stressed. The Fresno farm advisor reports, "As a result of field methods and practical demonstrations, furrow irrigation and the use of the soil auger for determining moisture penetration have been adopted by a large number of growers. In one community about 30 growers have adopted the furrow system and the use of the soil auger on over a thousand acres of vineyard and orchard." The farm advisor has performed a notable service in demonstrating and extending the use of the soil auger as the proper means of determining actual facts of moisture conditions, which in turn determine the proper time for irrigation. The soil auger has therefore become an important factor in vineyard management. "In the studies of penetration of irrigation water during 1921 it was found that in a considerable portion of the vineyard area of Fresno County (representative of the vineyard area of the San Joaquin Valley) there had developed a hardpan 16 to 18 inches below the surface. In many vineyards and orchards small irregular spots showed a complete lack of moisture in spite of irrigation, the leaves drying up and falling in the middle of the season. Subsoiling was suggested in many cases. Wherever tried out this practice proved beneficial. Where the ground had been subsoiled during the early winter of 1921-1922, no burned or dried-up areas appeared, while on adjacent parts of the fields not subsoiled the same old dry spots showed up as usual."

Cover cropping as a means of supplying necessary organic matter in the soil is an important factor in vineyard management. Nineteen twenty-two conclusions in the heart of the San Joaquin Valley grape region were as follows: (1) Cover crops should be planted in the early fall, in September if possible; (2) irrigate by the furrow method; (3) irrigation before planting does not produce as good results as irrigation after planting, especially with small-seeded varieties such as *Melilotus indica* and burr clover; (4) large-seeded legumes may be planted with success on pre-irrigated land provided arrangements are made for subsequent irrigation as needed; (5) small-seeded legumes planted on a mellow seed bed need not

be covered; (6) light top dressings of manure are advisable previous to planting; (7) *Melilotus indica* and burr clover are the two leading cover crops. The vetches, common and purple, and Canadian field peas produce fair results.

Demonstrations of successful use of recommended practices carried out by grower coöperation in Kings County, for example, are marked by suitable roadside signs bearing the insigna of the Agricultural Extension Service with brief facts regarding the principles exemplified in the vineyard. Vineyards of the coöperators serve as illustrative material for "meetings at demonstrations." Further important factors in vineyard management are discussed under "Vineyard Pruning."

Demonstration Vineyards.—The plan for the permanent demonstration vineyard prepared by the Division of Viticulture of the College is a three-cornered written agreement signed by the Division of Viticulture, the farm advisor, and an owner-coöperator. It is a private property on which the owner has undertaken to follow the advice of the Division of Viticulture. Twelve such vineyards continue in the San Joaquin Valley counties and in the Imperial Valley. The plan provides for a long-time project with established vineyards at various suitable points standing as demonstrations of results of methods exemplified and practices taught by the College. The major features which the permanent demonstration vineyard is being carried on to teach are: (1) Methods of planting and caring for the vineyard for three years; (2) trellising of the Sultania; (3) head pruning of the Muscat; (4) cordon pruning of the Emperor, the Malaga and the Cornichon varieties. These permanent demonstration vineyards are now three years old. Two have been abandoned and others selected to serve instead. While too early to draw final conclusions as to the complete effectiveness of the plan, it is evident that these selected living records in the field are highly valuable for teaching purposes. Of a permanent demonstration vineyard in Imperial County the advisor reports that the owner has so well followed the advice of the Division of Viticulture on his 40 acres of Malagas that the vineyards has been styled by authorities the best of its age anywhere. Over $2000 worth of grapes were sold from this vineyard 17 months after planting.

Grape Nursery Clubs.—Among the Boys and Girls' Agriculture Clubs of the State are 16 grape nursery clubs with a total enrollment of 132 members, 99 of whom report growing 486,140 grape cuttings valued at $6,165.85; total cost $3,525.40. This leaves a value above cost of $2,640.45. Eighty-three members demonstrated improved

methods of making cuttings with 360,340 cuttings. Seventy-one members demonstrated improved methods of development of cuttings with 113,340 cuttings. There is included in the work of these club members the making of grape cuttings and the care of same until they are disposed of from the nursery as rooted vines ready for the buyer to plant

a

b

Fig. 144.—(a) A demonstration of trellising grapes, San Diego County. (b) A demonstration vineyard in San Diego County.

in his new vineyard. Members in this club contest tried out both the common and mallet cuttings. On the average there was no difference as to the number and strength of those that grew. Those cuttings that were "heeled in" with the butt ends up until the buds just started to swell produced the most and strongest rootings.

Grape Acre Clubs.—The management and care of one acre of vineyard was the job of each Agriculture Club member enrolled in a grape acre club. There were in the State 12 such clubs with an enrollment of 121 members, 93 of whom reported a business of \$10,102.02 on 94½ acres of vines. The total cost was \$6,052.39, leaving a value above cost of \$4,049.63. Sixty-two members demonstrated the University methods of pruning on 62 acres. The county club leader of Fresno, the leading grape-growing county, writes,—"The grape acre clubs have come to be the largest contest in the county. The enrollment in this county made a rapid growth, due to the greater profits. This year, however, even with the big increase in enrollment, the net profits were less than last year, caused by a big drop in the price of raisins and the fact that many of the records are not completed, as several of the members have not received complete returns for their crop. This club is proving to be a very good demonstration in the better methods of cultivation, irrigation, staking, and pruning, especially to the foreign class of people who do not attend the regular demonstrations put on by the farm advisors. Though the farmer may not attend the demonstrations or take up the methods recommended by the farm advisor, these methods are taught to their children in the clubs, and from their results the father is won over to use the recommended methods."

Vine Pruning.—Out of the total 190 vineyard field demonstrations with an attendance of 8235 persons, 130 demonstrations, with attendance of 6068 persons, included at least some one of the many phases of vine pruning. Extension workers who have been in the field for ten years and more have commented on the high percentage of change in the groups of growers attending field demonstrations where such have been held with regularity during the past dozen years. The report of the Tulare farm advisor notes that cards filled out by those attending vine pruning demonstrations during the current year indicated that 77 per cent of the growers present had not attended a pruning demonstration before.

By field demonstration of method both before groups and individuals in answer to farm calls and through the establishment of demonstrations of results, farm advisors have extended throughout the vineyard areas of the State three vine pruning systems as taught

by the Division of Viticulture of the College: (1) *Head Pruning.*—This method of pruning gives the vine the form of a small self-supporting bush, with an upright "trunk" 18 inches to 42 inches high, depending upon variety of the grapevine pruned. The old method of head pruning established the head of the vine too close to the ground. "Bald-headed" vines with prematurely decaying trunks resulted. Cultivation close to the vine rows was also interfered with. An important advantage of the higher heading is in the closer cultivation permitted. (2) *Cane Pruning.*—This system of pruning develops a single trunk from 24 to 36 inches high. From the head of the trunk of a mature vine a desirable form is four arms, 6 to 12 inches long. A fruit cane 2 to 5 feet long is left at the end of each arm. A trellis is recommended. In newer vineyard areas, as a result of the teaching of the single trunk system, extensive acreage of single-trunk cane-pruned varieties will be observed in striking contrast to many older regions where vines with several trunks starting from a point near the ground will be noted as typical of the old method. (3) *Cordon Pruning.*—With this system of pruning a single long, comparatively slender trunk is extended horizontally along a wire about 30 inches from the ground until it reaches the next vine. Demonstrated advantages over the old method of training and tying to a single upright stake are: (*a*) increased fruitfulness of the canes, nearly all varieties bearing on the lowest buds; (*b*) high uniform quality; (*c*) promotion of size of berries and bunches.

Results secured are indicated by the Fresno farm advisor, who writes, "A very marked change has been noted during the past three years in the improvement in vine pruning, especially in the young Sultanina (Thompson seedless) vineyards of the county. Practically all the young Sultanina vines are staked with a small picket and suckered to one trunk with a definite head. Muscat vines are also staked and suckered to form a head at from 18 to 24 inches, instead of the old system of allowing the vine to form its own head at from 6 to 12 inches." The Kings County farm advisor reports, "As a result of four years of teaching, a majority of growers are now giving more attention to the proper care and training of young vines than in previous years. It is becoming common practice to train 2 and 3-year-old vines upon 2-foot stakes by each vine to secure erect trunks with vines headed at a uniform height to insure better maturing of grapes, to facilitate cultivation, and to minimize losses from mildew." These recommendations for vineyard pruning, a major phase of vineyard management, have been taught by demonstration of methods and results as the best means of accomplishing the

purposes set forth above, namely, to obtain improved quality of grapes and raisins with minimum costs of production per unit of product.

Citrus Orchard Management.—Covering all phases of citrus culture there were conducted during 1922 by the Extension Specialist in Citriculture and by the farm advisors a total of 149 field demonstrations in nine counties, with an attendance of 5608. There are at the time of making this report 294 plots for demonstration of results active in the State. Subjects covered in these demonstrations were,—cover cropping, fertilization, irrigation and control of soil moisture, subsoiling, laying out orchard and planting, pruning, pest control, disease control and tree surgery, top-working, trial of new varieties, windbreaks, treatment of frost-injured trees, frost protection, and orchard practice surveys.

Citrus Planting.—This is a problem in new districts, and to meet the demand for information a series of five planting demonstrations was held in Imperial County. Much interest was shown in these demonstrations, but because of the loss of nursery stock in the freeze very little planting was done.

Citrus Pruning.—This year there were some special problems in citrus pruning, owing to severe injury to trees from the January freeze. Immediately following the freeze field meetings were held in San Bernardino and Los Angeles counties, where different degrees of injury were pointed out and the growers advised to delay pruning for a year, or at least until summer. A second series of meetings was held on summer pruning of frosted trees, and a third on pruning of normal trees. There were in all 54 meetings in six counties with a total attendance of 2460. No results are available from pruning plots because of frost damage. A lemon plot in Ventura County established in 1921 showed much less frost injury to "long-pruned" than to "short-pruned" trees.

Citrus Pest Control.—Pest control schools were held in central and southern California at which the latest information on fumigation, spraying, and biological control was made available to the growers. It was clearly shown from the records kept by the horticultural commissioners that fumigation is far superior to spraying for control of citrus scale insects, though where the infestation is light citricola scale can be held in check in central California by spraying with lime-sulfur and miscible oil, or with lime-sulfur alone. In Los Angeles County a coöperative project on the control of citrus red spider was carried on with the Citrus Experiment

Station, and it was shown that the best control for inland districts is 2 per cent lime-sulfur with a spreader and the addition of 5 to 10 lbs. of wettable or atomic sulphur to the 200-gallon tank.

Citrus Disease Control and Tree Surgery.—Various fungus and bacterial diseases of citrus trees are becoming more widely distributed and apparently more virulent, and extension agents are giving considerable attention to their control. This year 22 meetings on this subject were held in six counties, with a total attendance of 732. There are now 37 active plots dealing with these diseases,

Fig. 145.—Extensive demonstrations have been held to show the method of inarching gophered citrus trees. The photographs show the method and the completed results. Los Angeles County.

13 in Butte County on control of citrus blast and 24 in southern California on trunk and root diseases. Spraying with 5-5-50 Bordeaux mixture prior to November 1 has been demonstrated to be an effective control measure for citrus blast. The plots on control of scaly bark stand as demonstrations of fine results that may be secured in the control of this disease by a proper scraping of the bark over and well beyond the diseased area.

Two types of tree surgery work have been carried on, first, the removal of sucker or adventitious roots from lemon trees, and, second, inarching for saving gopher-injured trees. Lemon trees are showing benefit from the removal of these adventitious roots. Plots on this will be continued. Nine meetings were held in Los Angeles

County demonstrating inarching, and the attendance was 319. Twenty-two plots have been established. Nurserymen report a sale of over 10,000 seedling trees for inarching during the past two years, which means that, allowing an average of four seedlings to a tree, at least 2500 trees have been treated in Los Angeles County alone.

Citrus Top-Working.—In the citrus orchards of this State are many off-type trees which may be made profitable by top-working. Improper top-working practice has resulted in a large percentage of failure. Top-working can be successfully carried out, and to demonstrate proper methods of doing this work and following it up, 25 plots have been established in three counties. The following conclusions may be drawn to date: Success is assured where the tree is healthy and trunk and roots are sound. It is wise to leave one or two nurse limbs for a full year after buds start. The growth of the buds is somewhat slowed down by this method, but the wood is of better quality and much more resistant to frost.

Trial of New Varieties.—It is desired to find an orange with the good qualities of the Washington navel but not so susceptible to June drop in the interior districts. In Butte County buds of four varieties have been supplied to eight growers, and old trees have been top-worked to these new varieties.

Windbreaks.—The damage to citrus trees and fruit from winds has reached enormous proportions and there is much interest in windbreaks. The farm advisor of Imperial County reports starting a project to demonstrate the value of a superior tree, *Tamarix articulata,* for windbreak purposes.

Treatment of Frost-Injured Citrus Trees.—The Extension Service is often called upon to do emergency work. This was the case following the severe freeze of January 1922 which killed many citrus trees and subjected thousands of acres to varying degrees of injury. The Extension Service immediately held a series of meetings and presented such information as was available at that time. Articles were also supplied to all papers interested. Following the 1913 freeze conflicting evidence was secured on the treatment of badly frozen trees, and in fact many people advised pulling the trees out. The Extension Service made a survey of orchards which had been rebuilt after previous freezes and outlined methods which had apparently been successful in salvaging trees. Forty-five plots have been established in southern California for a demonstration of the best methods known and a further study of (1) different methods and dates of pruning; (2) different methods of rebuilding badly frozen citrus trees; (3) the effect of quickly available nitrogenous

fertilizers; (4) the use of disinfectants in frost cracks. The total number of trees in these plots under observation and treatment by the Extension Service is 438, exclusive of the fertilizer test.

Date Culture.—A feature of the year's work unique in subject rather than extensive in scope of methods or of results has been a brief series of field and indoor meetings conducted in Riverside and

Fig. 146.—Following the freeze of 1922, tests and demonstration plots were established on treatment of frost injured trees. Previous experience had shown it was best to delay pruning of frosted bearing trees until recovery was well under way, and preferably for a year. A plot in San Bernardino County shows a better start toward recovery by the unpruned tree.

Cut No. 1 shows a tree as it appeared on May 24, 1922. Cut No. 2 shows the same tree two months later with no treatment, allowing a natural recovery to take place. Cut No. 3 shows a tree of the same degree of injury pruned on May 12 so as to remove the worst frozen wood. Cut No. 4 shows the same tree two months later. The tree has not put out nearly as good a type of growth as the unpruned tree.

Imperial counties for the study of date culture. The industry is growing in both the Coachella and Imperial valleys. The Imperial farm advisor reports a date growers' field day held at the Meloland branch of the Agricultural Experiment Station of the University of California. The following month a date pollination demonstration was conducted at the same place. A tour of date growers was also conducted in Imperial County. Representatives from the Bureau of Plant Industry of the U. S. Department of Agriculture accompanied the tour to discuss conditions of the various date gardens which were visited during the day's trip. The total attendance at three Imperial County field meetings was 190 persons.

RODENT AND PEST CONTROL

Rodent Control.—The State Department of Agriculture is vested with the duty of executing state laws governing rodent control. This work is carried on in the several counties by the county horticultural commissioners, who are representatives of the State Department of Agriculture and who coöperate very closely with the farm advisors. In 1918 a project was entered into covering coöperative squirrel eradication work between all farm advisors and county horticultural commissioners. As agreed in this project, the farm advisors have had charge of the educational program for rodent control. The county boards of supervisors have provided the necessary finances to successfully carry on the work, and the county horticultural commissioners have provided central stations for mixing and distributing poisoned barley and other materials. They have also enforced the state law requiring farmers to clean up their farms. This work has been materially assisted through the coöperation of the United States Biological Survey. The project as a whole has proved to be a splendid example of real coöperation between several interested agencies.

Rodent control methods were followed on 4331 farms, involving 710,208 acres and including 28 counties. In addition to the 49,171 pounds of poisoned barley distributed for this purpose, the use of carbon bisulphide was a very effective means of killing squirrels. Best results were obtained by concentrated campaigns after methods of control had been thoroughly explained and demonstrated at field meetings and farm bureau center meetings. By this method communities have set aside a certain week known as "squirrel week," have thoroughly organized their forces, and with the assistance of farm advisors have successfully cleaned up the squirrels during the

week's concentrated effort. Such communities as have had squirrel weeks over a period of several years are now practically rid of this rodent. The campaign method is well adapted to rodent control and is generally successful if farmers are made to feel a community responsibility and if the community is well organized and directed.

Coyote control is important in a number of California counties. The bounty system of control, though still practiced in some counties, has fallen far short of producing the most desirable results; consequently the use of expert poisoners and trappers has constantly grown, and the results they have obtained have generally been superior

Fig. 147.—A demonstration of killing squirrels by use of carbon bisulfide gas and igniting it. Sacramento County.

to the bounty system. In addition it is generally conceded that the use of expert hunters is more economical than the bounty system. In some of the counties troubled by coyotes the United States Biological Survey has cooperated in conducting control demonstrations through the use of poison and traps. Such demonstrations and their spread of influence have resulted in an immediate decrease of the livestock killed in the communities concerned.

In the past years jack rabbits have caused great crop losses in California, but the problem has been successfully met by the holding of rabbit drives. Jack rabbits are still a nuisance in several counties, and these counties have conducted rabbit drives during 1922 similar to those of past years. Three very successful drives were held in San Joaquin County with from 400 to 800 persons taking part in each.

One of these drives, covering 25 sections of land and consisting of 400 hunters, resulted in 3500 rabbits being killed. Tehama County held two drives with 700 rabbits killed.

Sixty-seven gopher field demonstrations were held in 11 counties, which demonstrations covered methods of trapping, probing for runways, and cutting, preparing and placing bait.

Smut Control.—Previous to 1921 the bluestone-lime treatment for the control of wheat smut was the prevailing method. The standard bluestone and formaldehyde treatments caused a certain

Fig. 148.—The results of a demonstration on the control of bunt on wheat, Sacramento County. The man on the left holds smutted heads in a given area of untreated wheat. The man in the center holds smutted heads in the same area of blue-stone treated wheat. The man on the right holds the heads from a like area of copper carbonate dusted wheat. The latter treatment is recommended.

amount of seed injury beyond the apparent control of farmers and were not wholly satisfactory. Consequently the Division of Agronomy, in coöperation with the Office of Cereal Investigations of the United States Department of Agriculture, worked to perfect a better method of smut control, and after considerable experimentation recommended the use of copper carbonate dust for widespread demonstrations. In order to give the method a fair and comprehensive trial, from one to five demonstrations were conducted by farm advisors in the wheat-growing counties of the State. These demonstrations consisted of plots on which copper carbonate dust was tested, side by side with the standard methods and with check plots. The results from these demonstrations, carried on in 20

counties and covering the different climatic and soil conditions of this large area, were compiled and made available after the harvest of this year.

The data obtained were confirmed by similar work carried on in Oregon, Idaho, Washington, and Australia, and warrant the following conclusions: (1) Copper carbonate dust applied at the rate of 2 ounces per bushel controls seed-borne smut when the whole surface of the seed is coated with the dust, and if the seed is not darkened by a heavy spore dosage, and if the dust and seed are thoroughly mixed. (2) There is no injury to seed germs from the copper carbonate dust. (3) Copper carbonate asserts a depressing effect upon smut attack from smut-infested soils and in this respect results superior to bluestone are the rule. (4) A stimulating effect upon wheat seedlings has been reported in many instances. This has been confirmed by greenhouse tests, where an average of 30 per cent increase in both root and plumule growth was secured over untreated seed. (5) A saving of seed over other methods of seed treatment is seen in the better stand which in turn is reflected in the crop. Crops from fields sown with copper carbonate treated seed almost always produce superior yields. (6) The general use of copper carbonate dust to prevent smut attack is retarded, (*a*) by the lack of suitable machinery for applying the dust, and (*b*) by the nasal irritation caused to those who apply the dust.

A small machine of the barrel-churn type has been devised by the Division of Agronomy and is proving very satisfactory for thoroughly mixing the seed with the dust. The Extension Service has drawn up full specifications and a blueprint for the making of this barrel-churn in order to supply all interested wheat growers. The nasal irritation caused by the copper carbonate dust may be avoided without serious discomfort by using dust masks similar to those used in cement factories. The results obtained from the copper carbonate dust method of controlling smut and the enthusiasm with which it has been received by farmers indicate its future widespread adaptation and that it will result in great financial returns to wheat growers. The determination of this method of control was the successful result of a well planned and executed project undertaken by the Division of Agronomy and the Agricultural Extension Service in conjunction.

Orchard Pests, General.—Insect control methods were followed on 2511 farms involving 23,133 acres. In addition to vast quantities of spray material used in this work 61,780 pounds of poisoned bait were distributed. Spraying recommendations were carried out on

2525 farms involving 29,790 acres. Farm advisors have done an increasing amount of work in reference to insect pests and plant disease control. This is reflected in the number of farm visits, office consultations, field meetings, demonstrations, etc.

In addition to others this work has included leaf roller, red spider, vine leaf hopper, pear root louse, blister mite, aphis, codling moth, thrip, grasshopper, army worm, sphinx moth, garden insects, peach worm, eel worm, scale insects, peach root borer, peach twig borer, crown gall, phylloxera, curl leaf of peach, pear scab, oak root fungus, apple mildew, pear blight, brown rot, puncture vine, morning glory, etc. After several years' work by the farm advisors it is gratifying to note that in some counties from 50 to 75 per cent of the orchards received disease and pest control treatments where previously such practices were not common.

Brown Rot disease has caused great losses in the apricot producing sections of the State, and its control in infected sections has become the most important consideration in apricot production. Not only is the apricot industry threatened, but the disease has spread to other deciduous trees such as prunes and Bartlett pears. The Deciduous Fruit Station at Mountain View after several years of research has developed control methods, which have been demonstrated by the farm advisors. Bordeaux mixture has proved the best spray for the control of brown rot, and, while at this time the data are incomplete, the figures indicate that a spray of stronger strength, say 7–8–50, is more effective than one of the standard 4–4–50 strength. The experiments at the Deciduous Fruit Station at Mountain View and the demonstrations conducted by the farm advisors indicate that emphasis should be placed upon the importance of spraying in the early blooming period, the necessity of spraying badly diseased orchards more than once during this period, the use of Bordeaux mixture, the value of cutting out the old diseased twigs and spurs which form the principle source of infestation the following spring, and the inadvisability of spraying apricots with lime-sulphur on account of the danger of injury. The critical period of spraying for this disease lies in the spring just before and during the blooming.

The farm advisor in San Benito County demonstrated the effect of a Bordeaux spray (5–5–50) as compared to oil emulsion (33–200) and lime-sulfur (50 lbs. dry to 40 gals.). The lime-sulfur and oil emulsion treatments resulted in partial control but caused undue burning and arrested bud development with consequent decreased yields. The Bordeaux spray plot produced 65 lbs. of fruit per tree as against 6.2 lbs. for the unsprayed trees, or an estimated increase

of $217 per acre. A demonstration in Napa County resulted in 100 per cent crop with but little brown rot, while adjoining unsprayed orchards had a serious attack of the disease. One apricot grower in Marin County produced only 100 boxes of fruit in 1921, but harvested 500 boxes in 1922 because he carried out the advice of the farm advisor concerning the brown rot control. Another grower in Marin County who followed brown rot control methods reported an increase of 50 per cent in yield, while his neighbor's unsprayed orchard was entirely unproductive. The farm advisor in Monterey County arranged for 11 brown rot control demonstrations, which were carefully planned and carried out. The results are thoroughly reliable and indicate (1) a dormant spray of oil emulsion or Bordeaux mixture has a controlling effect on brown rot; (2) Bordeaux mixture (5–5–50) gives good control, especially when applied twice during the blooming period; (3) a 95 per cent control was accomplished where Bordeaux mixture was applied at the one-fifth and one-half stages of bloom; (4) an application of Bordeaux dust effected no control. In some sections of the state, due to combinations or the improper carrying out of control methods, brown rot has not been greatly decreased. Because of the great economic importance of this disease to the apricot and prune industries of the state the farm advisors are continuing their control demonstrations during the year 1923.

Other Diseases.—The farm advisor in Mendocino County reports, "An outbreak of pear blight in Potter Valley was taken charge of by this office and the disease stamped out. The orchardists neglected to report any trouble and when discovered considerable headway had been gained, in fact, so much so that one man was determined to let the disease take its course. This man, together with other parties concerned, were persuaded to undertake a control campaign. After one week's work the orchards were freed of this trouble. A few diseased trees on which the blight made a reappearance were cut out. The work was 100 per cent effective. The growers were certain that if no other work had been done the past year the cost of the Extension Service had been justified."

Growers of the common Himalaya blackberry in Santa Cruz County have been suffering from heavy losses, anywhere from 25 to 50 per cent of the crop, from what is locally known as "red berry." A large part of the crop failed to mature but remained red, although fully developed. Investigation pointed to a tiny blister mite as the cause, and the farm advisor established two test plots to determine control methods. A spray of 4 per cent lime-sulfur and 2 per cent black leaf 40 during the dormant season, followed by a 1 per cent

lime-sulfur applied when the buds began to curl, resulted in complete absence of both the blister mite and the red berry. The unsprayed check plots were damaged to the extent of 50 per cent.

Peach worm infestation in Yolo County during 1921 was so severe that control measures were absolutely essential to the securing of an almond crop. The farm advisor established four demonstrations in the county and demonstrated that complete control could be effected by spraying with lime-sulfur, arsenic of lead and nicotine sulfate. The farm advisor in Alameda County obtained from 50 to 100 per cent control of the peach root borer by the use of paradichlorobenzene. This same treatment gave excellent results in San Benito County, and is especially welcomed because it is more economical and does not cause tree injury from wounds. It is estimated that farmers in Alameda County received an additional $10,000 for their crops by controlling thrips with nico-dust applied by a power duster. The application of 5 per cent nico-dust has also saved thousands of dollars for the pea growers of Alameda County, as this dust successfully controlled pea aphis which for several years was unchecked. An itinerant assistant farm advisor was sent to Placer County to work on the control of the peach twig borer which was doing great damage there. He located 14 test plots in different parts of the county and his work demonstrated the effectiveness of the following control measures: (1) lime-sulfur applied during the pink stage, (2) arsenical poison applied just previous to blossoming, (3) nicotine sulfate applied during the pink stage.

During the period 1919-1922 the farm advisor of Monterey County carried on tests for the control of wild morning glory. His results may be summed up as follows: (1) Wild morning glory can be successfully eradicated by the introduction of carbon bisulfide into the soil. (2) The application must be made when the soil is comparatively dry. (3) Satisfactory kills have been secured as follows: Make holes a ½-inch in diameter, probing to a depth of 18 inches, spaced 3 feet apart each way; pour 4 ounces of carbon bisulfide into each hole and fill. (4) Effects of the carbon bisulfide are apparent on the morning glory in one week's time. The morning glory is practically dead within a month after the application is made. (5) In every case thus far an increase in yield has been apparent the following year on areas treated with carbon bisulfide. (6) Carbon bisulfide should be used on small patches of morning glory. These small plots can be easily killed out and the spread stopped. The treatment is not recommended for large areas because of the expense. (7) In applying carbon bisulfide care should be taken not to endanger useful plants.

One of the interesting developments in insect control work is the establishment of the Orange County insectary. This undertaking followed six months of discussion of biological control of scale insects and was definitely started at a representative meeting called by the county farm advisor of Orange County. The undertaking was financed by a tax of one-fourth of a cent for each packed box of fruit shipped by the various citrus associations in the county. A suitable building was erected and equipped and a competent staff employed. Work was then started to rear the natural enemies of various species of mealy bug and scale insects that attack citrus trees. Although the enterprise is still young some millions of liberations have already been made.

APICULTURE.—Honey bees are desirable for the proper pollination of nearly all fruits and berries, some vegetables, and alfalfa and clover when grown for seed. For this purpose alone it is estimated that at least one colony of bees should be kept for every five acres of fruit or for a smaller acreage of berries or vegetables. It is conceded that the bees will increase the crop in the case of some varieties from 10 to 100 per cent, producing more perfect, therefore more salable fruit. Beekeeping is becoming of more significance as fruit growers realize the beneficial part played by bees in pollination, and hives are being provided for this purpose often without regard to the value of honey. The low production of prune and apricot orchards in Placer County was investigated by the Division of Pomology and pollination studies undertaken. These studies clearly demonstrated that the bees played an important part in pollinizing fruit and resulted in 87 farmers placing 705 swarms of bees in their orchards. A number of the farm bureaus have organized beekeeping departments which are carrying on excellent programs of work covering all phases of the industry. The Beekeepers' Department of the Shasta County Farm Bureau held monthly meetings at different apiaries during the honey flow season, at which demonstrations in queen rearing, control of foul brood, etc., were given. The farm advisor in Orange County has located demonstration plots for swarm control, spacing of frames, and moisture control, all of which demonstrations are now in progress. The farm advisors report that beekeeping was introduced and the handling of bees improved on 184 farms, involving 2370 hives, and that farm calls and office consultations relating to the subject are increasing.

Beekeeping Schools.—In December 1921 an extension school for beekeepers lasting one week was held at Los Angeles with a large attendance of beemen. There has been a demand from at least five

counties for similar schools, but the College of Agriculture has been unable to supply the necessary staff for instruction.

Beekeeping Clubs.—During the year seven bee clubs were organized in Fresno, Los Angeles, Kern, and Napa counties with an enrollment of 45 members, of which 30 members had 139 hives, which, together with the honey produced, were valued at $1346.77. As a result of their club work the 30 members made a profit of $742.95. Nine of the members with 25 hives demonstrated the use of pure queens, while 13 of the members with 77 hives demonstrated the control of foul brood. This piece of club work resulted in 9 farmers starting 64 hives with pure queens, and 18 farmers starting 500 hives with standard equipment.

LIVESTOCK PRODUCTION

DAIRY IMPROVEMENT.—The outstanding feature of dairy improvement work has been the setting of a goal and the adoption of a program of work which outlines means whereby this goal may be reached. Because average butter fat production per cow per year is a good measure of the status of the industry, and because the work is planned to benefit the industry of the whole State, a goal of 265 lbs. of fat per cow per year in 1930 has been established for the State. The present average production is about 182 lbs. of fat. The program of work, which specifies the activities through which we hope to reach this goal, consists mainly of methods which will secure:

1. More and better cow-testing associations.
2. Wider use of good pure-bred dairy bulls.
3. Better feeding practices.
4. Better care of dairy cattle.
5. More control and eradication of cattle diseases.

Dairy Surveys.—Dairy surveys have been conducted in Humboldt, Glenn, Sonoma, Marin, Stanislaus, Merced, Kings, Riverside, Orange, and Imperial counties. From these surveys have been secured the names and addresses of owners of scrub, grade and pure-bred bulls, number of cows in each herd, number of silos, silage crops used, size of farms, and other information of value in outlining dairy improvement programs for these particular counties. These surveys have been especially valuable in Humboldt, Sonoma, Marin, and Imperial counties in preparation for pure-bred bull campaigns, and in Glenn, Stanislaus, Merced, Kings, and Imperial counties in preparation for cow-testing campaigns.

Dairy Exhibits.—The Extension Service has arranged exhibits for fairs in San Joaquin, Riverside, Sonoma, Orange, San Diego, San Bernardino, and Los Angeles counties which have shown the benefits of cow-testing, pure-bred sires, better feeding practices, etc.

Cattle Secured.—The Extension Service has been instrumental in the purchase of 537 pure-bred dairy cows by the dairymen in 15 counties, and in the purchase of 352 high grade dairy cows by the dairymen in 10 counties.

Fig. 149.—An exhibit of four generations, illustrating the results of using pure bred sires, at a meeting of the dairymen's department of the Los Angeles County Farm Bureau. Three hundred and seventy-one pure bred bulls were placed on farms in 1922.

Cow-Testing.—Believing that a good cow-testing association is an effective means of improving dairy conditions much effort has been placed on this work. The value of the association depends largely upon the tester, hence careful attention has been given to the selection of 12 new testers, and in most cases the associations have been organized on a higher fee per cow in order that the testers' wages may be increased and more capable men secured. Closer coöperation between the associations and the Extension Service has been secured by the frequent conferences with testers and by the State monthly report of association activities.

During the year 1922 twelve new associations were organized and the number of cows in associations increased from 31,309 to 34,106. In addition, in Imperial County three associations have been organized with 2900 cows, but testing did not begin until December 1, 1922. In San Luis Obispo County, where a farm advisor has recently been placed, and in Del Norte County, where there is no farm advisor yet, there are two associations coöperating with the Agricultural Extension Service, which have 2156 cows under test. This makes 1075 members, employing 37 testers, who are testing 39,162 cows in regularly organized cow-testing associations. In addition to the cows in the regularly organized associations, dairymen with their own outfits, or who are doing official work, are testing 2845 cows. Thus, beginning December 1, there were 42,008 cows in the state under test.

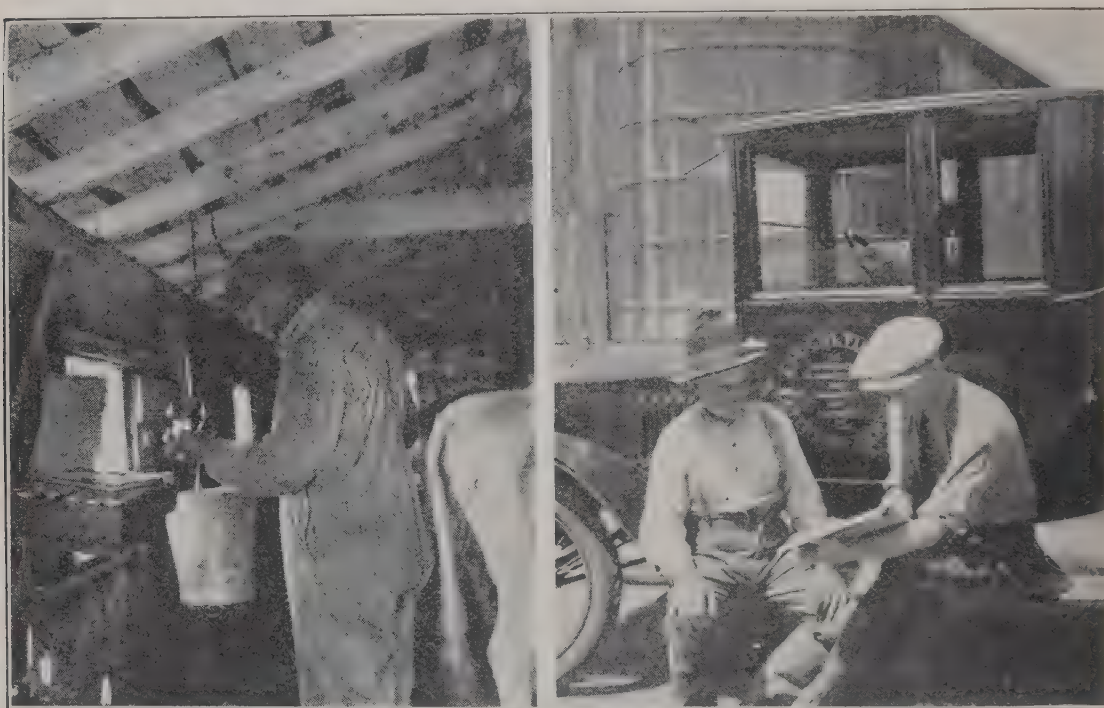


Fig. 150.—Left, a cow tester employed by the county farm bureau, weighing the milk and taking samples in the barn. Right, the assistant farm advisor interpreting the record to the local coöperating farmer.

An innovation in cow-testing association work which has proved very effective is in the method of organization. Heretofore the organization of associations has been largely by the farm advisor working with a local committee. Feeling that efficient cow-testing association work is of benefit also to the creameries, bankers, and other business interests, and knowing that in many cases a direct influence could be brought to bear on the dairymen, a plan was devised to interest the business interests of the community. In this plan each coöperating agency was given a definite part of the work

to do. This method was used in Stanislaus and Merced counties, in which only 900 cows were then being tested. By this plan their number was increased to 6513. A similar plan was used in Imperial County, where there were no cows on test, and there 2900 cows were secured. The plan was tried in Kings County, where 402 cows were under test, and approximately 1500 have been added. This method seems not only more effective in increasing cow-testing association work, but is beneficial in that it creates a better understanding and a community of feeling between the farm and the town folk.

In connection with the cow-testing work in Kings, Tulare and Fresno counties, and in coöperation with the California Dairy

Fig. 151.—The "funeral" of a scrub bull in Marin County.

Council, a trial of a scrub bull was held at the Fresno Dairy Products Show. A large crowd displayed much interest, and it is believed that the trial will aid in increasing interest in pure-bred sires and in cow-testing work.

The necessity of using pure-bred bulls has been urged in each association, and as a result San Diego, Kings, Riverside, and Delhi associations have only pure-bred bulls at the head of the association herds. Other associations have one or more grade or scrub bulls in the herds, but are attempting to replace them as early as possible. While it is not possible to state definitely how many pure-bred bulls have been purchased as a result of cow testing association work during the last year, an indication of its influence is given by the fact that cow-testing association members purchased 104 pure-bred bulls.

During the first year of association work the largest activity, usually, is that of getting rid of low-producing cows. Out of 36,952

cows tested during the past year, 3063, or 8.3 per cent, were disposed of as unprofitable, in comparison with 7.1 per cent during the previous year. This means that in the average association herd of 36 cows three of them prove unprofitable and are sold. On the average, each of the 1032 members have three cows less to feed and care for, but can use that feed and labor they were wasting on these unprofitable cows to make the remaining good cows more profitable.

The members of the association at Corcoran in Kings County report at each monthly meeting if they have any unprofitable cows

Fig. 152.—The first bull in a pure bred sire sale in Stanislaus County.

for sale, and as soon as a carload can be accumulated they are shipped. This practice has proved so satisfactory that already two carloads of culls have been sold.

A summary of the yearly records of twelve associations having 14,408 cows under test shows that they averaged 273.2 pounds of fat for the year. The estimated average production of the dairy cows in the State is 182 pounds of fat. This difference of 91.2 pounds of fat between the average cow and the association cow when applied to the 34,106 cows in associations would amount to the increased value in butter fat production of $1,555,000. The data also show that the men who continue in the work are able to obtain higher production. For example, the Petaluma association average has increased from 233 pounds in 1920, to 248 pounds in 1921, to 256 pounds in 1922. The Kings County association has increased from 232 pounds in 1919 to 252 pounds in 1920, 263 pounds in 1921, and

282 pounds in 1922. The records of many of the associations show that the lowest average production is found in the herds that are under test for the first time.

Wisconsin with 60,000 cows on test leads the United States in numbers, but California with 40,000 is the second State. Wisconsin has 2,800,000 dairy cattle with about 2 per cent on test, but California

Fig. 132.—Where the pure bred bulls went in the Marin County campaign.

has 780,000 dairy cattle with about 5 per cent on test. However, even though we have in proportion to our dairy cattle population over 2½ times as many cows on test as does Wisconsin, the leading dairy State, the aim should not be mere numbers but quality of service rendered. The work in California has grown to these proportions because dairymen have found it to be a necessary and profitable investment. The future of the work will depend upon the extent to which our dairymen learn of its value and appreciate its necessity,

Better Sires.—Emphasis has been placed on the necessity of using pure-bred sires, and through various methods 371 pure-bred dairy bulls were placed in 1922 as compared with 185 in the year 1921. It is estimated that 104 of these pure-bred bulls were placed through cow-testing association work, 219 through bull campaigns, 2 through bull clubs, and the remaining 46 through general advocacy of pure-bred sires. If, as we confidently believe, at least 300 of these bulls replaced grade and scrub bulls it is estimated that 11,000 additional cows, which heretofore were bred to scrub or grade bulls, are being bred to pure-bred bulls.

Believing that the influence of the community could be used effectively in placing pure-bred sires, projects covering such a method were put into effect in Humboldt, Sonoma and Marin counties, and a similar project has recently been under way in Imperial County. In Humboldt County there were 19 groups of coöperating agencies, and in Sonoma and Marin counties 111 individuals or institutions coöperated. The Humboldt County campaign placed 104 pure-bred bulls during the 1922 campaign and in a fellow-up campaign in 1923 has placed 93 more. Sonoma-Marin counties organized 12 committees consisting of 62 men, who in 30 days sold 115 bulls. When all the orders and deposits were secured the bulls were selected by a committee of three and shipped in by carload to the buyers.

A dairy cattle show supported by the communities in western Sonoma and Marin counties under the direction of the farm advisors there aroused considerable interest in better dairy cattle and was of value as preliminary educational work in the pure-bred sire campaign. A trial of the scrub bull was conducted by the Extension Service at the Sonoma-Marin Counties Fair at Petaluma. At both of these events a large crowd was thereby interested in pure-bred sires. In these campaigns the interest and coöperation of breeders in the State was secured, and as a result bulls of excellent breeding and individuality were secured at lower prices than those at which the dairymen could otherwise have bought them.

This plan, slightly modified, will be used later in Kern, San Luis Obispo, Imperial, and possibly in other dairy counties.

Because most of the herds in the dairy sections are quite large it has not been found advantageous to organize many bull associations. Two such associations, however, were organized during the past year, one in Inyo County with 18 members and one in Kern County with 35 members.

Better Feeding—Most of the work toward better feeding is done through the cow-testing associations. The 35 testers in those associ-

Fig. 154.—The Ventura County pure bred calf club ranged up for inspection of the traveling farm bureau conference. This calf club is still continuing and enlarging its work in 1923.

ations confer with the farm advisors and with the dairy specialist on rations and on feeding practices which they advocate among their membership. The increased production in cow-testing associations is probably as much due to better feeding and better care as to replacing low producers with higher producers.

Silos.—While no definite silo campaigns have been carried on during the past year, the Extension Service has continually advocated the use of silage, and in 14 counties has been directly responsible for the building of 57 silos. Advice on silage crops, time for cutting, etc., has been given in many counties, and tests for silage crops have been made in Lassen, San Benito, Marin, and Mendocino counties in which varieties of crops for silage have been studied.

Balanced Rations.—Meetings at which rations on feeding practices have been discussed were held in Humboldt, Mendocino, Imperial, Orange, Marin, Kern, Los Angeles, Riverside, San Joaquin, San Diego, Stanislaus, and Tulare counties. Farm advisors in 33 counties have formulated 1523 rations for livestock and poultry, the great majority of which were for dairy cattle.

Dairy Calf and Heifer Clubs.—During the past year there was an increase from 29 to 35 clubs. New clubs were organized in Riverside, San Benito, Yolo, Ventura, and Madera counties. The clubs are all organized in the dairy districts of these counties, and have resulted in the introduction of 154 pure-bred calves and heifers and 60 grade calves. The clubs have 214 members who have completed their demonstrations and reported. As a result of their experience and training in the clubs, improved methods of feeding have been practiced by 196 of the members. The operation of these clubs has influenced 15 farmers to introduce 31 pure-bred heifers, 19 farmers to use improved methods of feeding, and 17 farmers to use pure-bred sires.

In the Ventura County Calf Club exceptionally fine calves were secured by the eight new members to continue the calf club work. The 11 members continuing from the previous year held various meetings, picnics and barbecues to arouse interest in club work. Seven of the calves were taken to the State Fair, where they won prizes in the club classes and also junior and grand championships, and a $350 silver cup given by the Holstein-Freisian Association of America. To date four of these calves have been bred to the bull that was Grand Champion at the 1922 State Fair.

In Humboldt County the club continuing from the year 1921 was divided into a grade heifer club with 12 members, a pure-bred bull club with 7 members, a pure-bred heifer club with 4 members, a grade Jersey heifer section with 15 members, and a grade Guernsey

club with 11 members. Forty-eight of these calves were exhibited at the County Fair. Winners in the club were sent to Davis to the annual club convention.

In Glenn County there has been especial interest in dairy calf clubs, three new clubs having been organized this year, thus making five active clubs. Twenty boys were enrolled in the Holstein club, 13 in the Jersey club, and 4 in the Guernsey club. The members have some excellent stock, and made 108 entries at the County Fair and two at the State Fair.

Fig. 155.—An assistant farm advisor inspecting the report of a girl calf club member, Stanislaus County. These records are used to demonstrate methods of better dairying for the benefit of the parents and the community.

In Merced County the Dos Palos Holstein Calf Club held a junior community fair at the close of the year's work. This club was largely responsible for the reorganization and continuance of the farm center at Dos Palos.

Cow and Calf Clubs.—There were five cow and calf clubs organized for the first time in Glenn, Stanislaus, Merced, and Kern counties. The object of these clubs is to complete the heifer and calf clubs by bringing the heifers into production and show that they can produce milk and fat at profit; also to teach members proper methods of feeding and caring for producing cows.

Twenty-five boys completed their demonstrations and reported on their work. The average daily production per cow was 25.4 pounds of milk and 1.44 pounds of fat. Records show that the total value

of the animals and products above the total costs on the 25 cows was $4,044.31.

In Stanislaus County a Jersey club of 14 members was formed. On Jersey Day in Modesto a number of the cows were exhibited. One member of this club, Marguerite Conant, exhibited her cow and calf at the State Fair, where she won the calf club contest and also the butter fat contest, with cash prizes amounting to $90.

Goals for 1923.—If we are to attain our goal for 1930 of 265 pounds of fat for the average California cow, a definite advance toward it must be made in 1923 and each year thereafter. At the annual Extension Service Conference a program of dairy improvement was adopted and goals established for 1923. The program consists of securing the adoption by the dairymen of the State of certain proven practices, which will enable them to attain higher production at a lower cost for the capital and labor involved.

Beef Cattle Improvement.—Beef production in California is in general carried on by large operators and is rarely found on the smaller farm. Extension work with the beef cattle men continues to be small in amount as compared with that carried on with dairymen. There is increased interest in range improvement, however, and the addition of an associate professor for range management in the Division of Forestry of the College of Agriculture, which has taken place this year, has added impetus to this work. A cattle auction sale was held again last year in Nevada County at which about 200 head of cattle were sold. The grading demonstration and sale planned for Shasta County for February 1922 failed to materialize as an auction sale, but the cattlemen became interested in grading and selling on quality. Cattle grading demonstrations were held in November at both Hat Creek and Fall River in Shasta County and were attended by practically all the cattlemen in those valleys. The grading was done by the United States market representative at San Francisco, and was done as a preliminary to auction sales planned for February.

Better Sires.—Some 23 pure-bred beef bulls were placed on farms in Lassen, Mendocino, Orange, and Shasta counties through the work of the farm advisors, in addition to nine pure-bred bulls placed on farms in Napa County by the beef calf club. In Shasta County the influence of the pure-bred sire was brought out in the feeding and grading demonstration, and a party of stockmen from that region attended a bull sale at Davis, held in connection with stockmen's week, where they purchased 14 pure-bred bulls.

Range Improvement.—Range improvement tests were carried on during the year in Monterey, Santa Cruz, Shasta, and Yuba counties. In Shasta County six definite protection areas have been fenced off during the past year and these areas will be carried on during coming years. In addition 200 pounds of wild oats seed has been sown this fall on six range areas for trial, and other forage plants are to be tried during the summer. In Santa Cruz and Monterey counties Harding grass plantings have been made in the mountain areas. This grass has grown successfully in Santa Cruz County, but so far has been a failure in Monterey. In Yuba County a number of forage grasses have been introduced in the foothill areas.

Coöperative Grazing.—A coöperative grazing association was carried on in only one county, the association in El Dorado County having completed its fourth year of successful operation. Three hundred and thiry-nine cattle belonging to 14 different owners were grazed throughout the season on the national forest at an approximate cost of $3.00 per animal. Three hundred dollars of this cost, however, was spent on permanent improvements on the range, and this will enable the association to care for about 400 head this year.

Beef Calf Clubs.—Boys' agricultural clubs with beef calves were carried on in Inyo and Napa counties. The club in Inyo County got underway in the fall with eight club members starting with pure-bred short-horn heifer calves. The Napa club, with 15 members, secured and developed 15 pure-bred short-horn calves, 9 of which were bulls and 6 heifers. The contest was closed at the time of the county fair in August and the animals were exhibited at the fair. All these animals will be retained on farms in Napa County. They were given an appraised value at the close of the contest of $2425. The total cost of the project was $1,783.85, leaving a net profit of $641.15, or an average profit of $42.74 per member .

SWINE IMPROVEMENT.—Extension work looking toward swine improvement was conducted in nearly every county in the State centering largely about pig clubs, fat hog auction sales, and so-called "Pork Days." This latter activity was carried on in Fresno, Merced, Shasta, and Stanislaus counties last year, the Merced and Stanislaus work being done in coöperation in a joint "Pork Day" held at Turlock on October 31.

The Kings County Pork Day, which has been an annual affair for the past three years and is held in November, was postponed last year until March. This activity is in reality a feeding contest, prizes being offered for the best market hogs exhibited as carlots, lots of five, and as individuals, the whole affair culminating on Pork Day

when ajudications are made, prizes awarded, and the hogs auctioned off in carloads. This even affords an opportunity to emphasize desirable breeding and feeding methods for hogs. The judging is done as a demonstration and reasons for the placings explained by the judge. Special prizes are offered for carloads of animals that are shown by farm centers as communities, at least five owners being represented in each car. Pig club work is also emphasized on these occasions and special classes are made for animals fed and exhibited by pig club members.

In the Shasta County contest, closed at the time of the Anderson Fair the last of September, six farm centers participated and 350 hogs were shown. Eight hundred and fifty-two hogs (ten carloads) were exhibited and sold at the Fresno Pork Day, held at Kearney Park on October 20. Forty-five different farmers exhibited 495 animals at the Stanislaus-Merced event held at Turlock on October 31. Over 1000 farmers attended these three demonstrations.

Better Sires.—No specific campaigns to put out pure-bred sires for swine herds were made during the year, since pure-bred boars are in common use throughout the State and the grade or scrub boar is rare, particularly in those sections of the State where pork production is an important industry. The spread of influence of the Pork Day work and the auction sales in extending the use of pure-bred sires cannot be put in figures, but it is known that 57 boars and 84 females were placed on farms as a direct result of work of farm advisors with individuals in the counties of Contra Costa, Fresno, Imperial, Lassen, Mendocino, Merced, Napa, Orange, San Bernardino, Santa Barbara, Shasta, Stanislaus, and Yolo. This does not include those animals placed through the medium of pig club work. An example of the influence of a pure-bred sire was shown at the Fresno Pork Day sale, where pigs exhibited by the Squaw Valley Farm Center topped the sale. These pigs were sired by a pure-bred boar, brought into the community through the pork improvement program of the farm center, and were out of ordinary mountain sows.

Better Feeding.—Farm advisors report a general tendency over the State to market hogs at an earlier age, through more intensive feeding methods, largely as a result of the feeding demonstrations conducted in connection with the auction sales, "Pork Days," and pig club work. Thirteen counties report 91 farmers adopting self-feeders for hogs during the year.

Stanislaus County, where considerable work has been done with swine growers, has a record of 27 farmers who adopted this method

of feeding fattening hogs. In Shasta County, where in past years the practice has been to market a crop of hogs during a good acorn year, fattened largely on acorns and consequently soft and of a very low grade of pork, the feeding demonstrations have resulted in more even marketing of grain-fed hogs turned off at an earlier age. The hogs sold at both the Cottonwood and the Anderson auctions in this county, six cars in all, graded as No. 1 hard grain-fed hogs and brought the highest market price.

One feeding demonstration was conducted in San Joaquin County to demonstrate the value of dairy by-products in pork production in a region where the common practice has been to sell whole milk and depend on the creamery to return a profit for the skim milk. Hogs fed for a period of 110 days on barley and skim milk made an average gain of 1.46 pounds per day at a cost of 5.4 cents per pound. The whole operation returned a profit of $56.05 on an investment of $143.10 in feed and labor. Fresno County reports a summary of pig club feeding which shows an average profit of $4 per per animal for those members feeding a balanced ration and $3.02 for those that were fed an unbalanced ration·

Hog Feeding Clubs.—A total of 71 pig feeding clubs were carried on in 27 counties in the State during the year, with an enrollment of 544 members (464 boys and 80 girls), 491 of whom finished their contest and turned in completed records. These boys and girls raised 619 pigs, 562 of which were marketed for pork and 57 retained on farms for breeding purposes. The animals raised represented a value of $12,836.14, of which $3,247.33 was net porfit. Pig clubs continue to be a valuable means of carrying on work for swine improvement, both from the standpoint of better breeding and that of better feeding of swine. Farm centers are taking an increased interest in the work of boys and girls along these lines, and the fact that nearly 75 per cent of the animals used in club work are pure-breds, fed along approved methods, and that the average net profit per animal in the feeding clubs the past year was $5.25, is having noticeable effects in the State. All the common breeds of fat hogs are represented in these feeding clubs. For instance, the Ventura County clubs last year used pure-bred barrows of the Poland China, Duroc Jersey, Berkshire, and Hampshire breeds. These clubs closed their contest at the time of the county fair, the fat barrows being exhibited in the regular classes in addition to the club classes. A Berkshire barrow, shown by a club owner, was returned first prize winner over animals exhibited by three different swine breeders.

Many boys in feeding clubs enlarge their operations and become real swine breeders. Four of the boys in the San Bernardino club last year raised quite a number of hogs in addition to those they had in the contest. One member of this club sold animals to the San Bernardino County Farm and to the State Hospital at Patton to be used as herd sires.

Sow and Litter Clubs.—The sow and litter club is the logical follow-up of the pig feeding club and thirteen such clubs were organized during the year following the completion of feeding club

Fig. 156.—A prize winning hog in the boys' agricultural club at Bishop, Inyo County. These boys exhibited their livestock at the school for the benefit of the community. There are 71 such pig feeding clubs, with an enrollment of 544 members.

work. Seventy-five members enrolled in these clubs and by December 1 fifty-four of these members had completed their work and turned in records. These 54 members owned a total of 254 pigs at the end of the contest period in addition to their sows, 238 of these pigs being pure-bred. An example of this type of club is the one organized in Napa County, where 12 members enrolled. Eight of them carried the work through to completion and turned in records. These members owned three Poland-China sows, three Berkshires, one Duroc-Jersey, and one Hampshire. A total of 52 pigs were raised. These eight sows and litters were shown at the county fair, winning 29 ribbons and $71 in prize money.

SHEEP IMPROVEMENT.—Very little work along lines of sheep improvement was done during the year. One farm center in Marin County undertook a sheep improvement project and brought in 22 registered Shropshire buck lambs and 9 pure-bred Shropshire ewes. Santa Cruz County reported 3 registered rams and 20 registered ewes placed on farms. The work started in Yuba County during the past two years has been taken over and carried on by the wool growers' association.

Lamb Feeding Clubs.—Only one lamb club was carried on by the Extension Service. Four members completed their project of raising ewe lambs.

POULTRY IMPROVEMENT.—The importance of the poultry industry in California, as well as the demand made by the poultrymen for improved methods, has resulted in the accomplishment of several important projects during the year 1922. Poultry departments of county farm bureaus have been organized in 11 counties, with a membership of approximately 2000, made up primarily of commercial poultrymen. These departments coöperated in the carrying on of the Agricultural Extension Service program as well as conducting county projects of importance. Two extension specialists devote their entire time to demonstrational work and several assistant farm advisors spend the greater part of their time in poultry activities. During the year 1922 the Agricultural Extension Service assisted at 256 demonstrations and demonstration meetings attended by 18,930 poultrymen. Poultry practice was modified on 2360 farms. The major projects that the Agricultural Extension Service had a part in during the past year are as follows:

Poultry Housing.—The standardization of a housing project was outlined at the farm advisors' conference in January 1922. The project as outlined consisted of three parts, (1) the listing of university shed-roof houses in the county, (2) the conducting of demonstration meetings and tours where housing fundamentals could be discussed and buildings studied, (3) the construction of a demonstration house in poultry communities.

As a result of this project 20 commercial houses, having a total capacity of 30,000 hens, were listed as demonstration houses. Forty-one demonstration meetings attended by 1282 people and six housing tours, attended by 245 people, were conducted during the year. One hundred and forty-three farm calls on housing were made by members of the Agricultural Extension Service. One demonstration house was constructed in Santa Cruz County, attended by 50 poultrymen; two others are projected, one in Sacramento and one in Napa County.

The Agricultural Engineering Division is coöperating in the construction demonstrations and expects to develop this phase of the work to a greater extent in 1923.

Poultry Feeding.—The Agricultural Extension Service conducted 80 demonstration meetings in poultry feeding during the year with 2628 people in attendance. Seventy-eight farm calls were solicited by poultry raisers having feeding problems. The Poultry Department of the Los Angeles County Farm Bureau conducted a feeding test at the Pomona Egg-Laying Contest to determine the feeding value of several manufactured milk products. This test was watched with interest by the poultry raisers of the State. The popularity of the first year's work led to additional projects along the same line that are now under way.

Poultry Breeding: Egg-Laying Contests. — As previously mentioned, three egg-laying contests are being conducted by poultry departments of county farm bureaus in coöperation with the Poultry Division of the College of Agriculture and the Agricultural Extension Service. They are located in Santa Cruz, Sonoma, and Los Angeles counties. These contests are stimulating a decided interest in better stock as well as demonstrating better methods of housing and feeding.

The Petaluma contest carried on poultry culling tests in 1922. The results of these tests are to be used in that district to stimulate interest among the poultry raisers in systematic culling of their flocks.

Poultry Culling.—There is a continual demand each year for culling demonstrations. The poultry specialists conducted 162 demonstrations attended by 5963 people. The farm advisors conducted 42 additional demonstrations attended by 690 people. Follow-up cards turned in at these meetings show that 80 per cent of the people had never attended such a culling demonstration before and that the 20 per cent who had attended previous demonstrations had culled 272,568 fowls with excellent results. A further study of the follow-up cards indicates that 1,077,437 fowls were to be culled following the demonstrations of 1922. In addition to the demonstrations, several culling projects are under way where accurate production records of culls and selected hens are kept over a period of several months to a year.

Accredited Hatcheries.—The Poultry Department of the Sonoma County Farm Bureau is continuing the accredited hatchery project started last year. The combined capacity (every three weeks) of the 19 hatcheries on the list is 1,451,000 eggs. This project has been largely responsible for bringing into the county 10,000 pedigreed cockerels, as well as for the removal from breeding flocks of 80,000 culls and 8000 birds "off color."

Flock Inspection and Certification.—The Poultry Department of the Alameda County Farm Bureau is continuing the flock inspection and certification project as started last year. Fifty thousand breeders have been inspected for the 1923 hatching season. Seventeen hundred pedigreed males have been brought into the county as a result of this project.

a

b

Fig. 157.—(*a*) The use of charts and live birds at a culling demonstration in Sonoma County. There were [illegible] such culling demonstrations held, attended by 6653 persons.

(*b*) A demonstration poultry house on which is posted the County Extension program of work, shown to a traveling conference, Santa Cruz County.

Poultry Registry Association.—The Poultry Department of the Sonoma County Farm Bureau has a poultry registry association under way. The object is to list and keep a careful record of all pedigreed fowls in the country. On November 1, 1922, 241 birds had been registered and applications received for 400 others. The registration project is closely correlated with the accredited hatchery and egg-laying contest projects of the county.

Utility Poultry Shows.—The poultry departments of Sonoma, Alameda and Santa Cruz counties conducted utility poultry shows during the fall of 1922. Three thousand fowls were exhibited and judged on a utility basis.

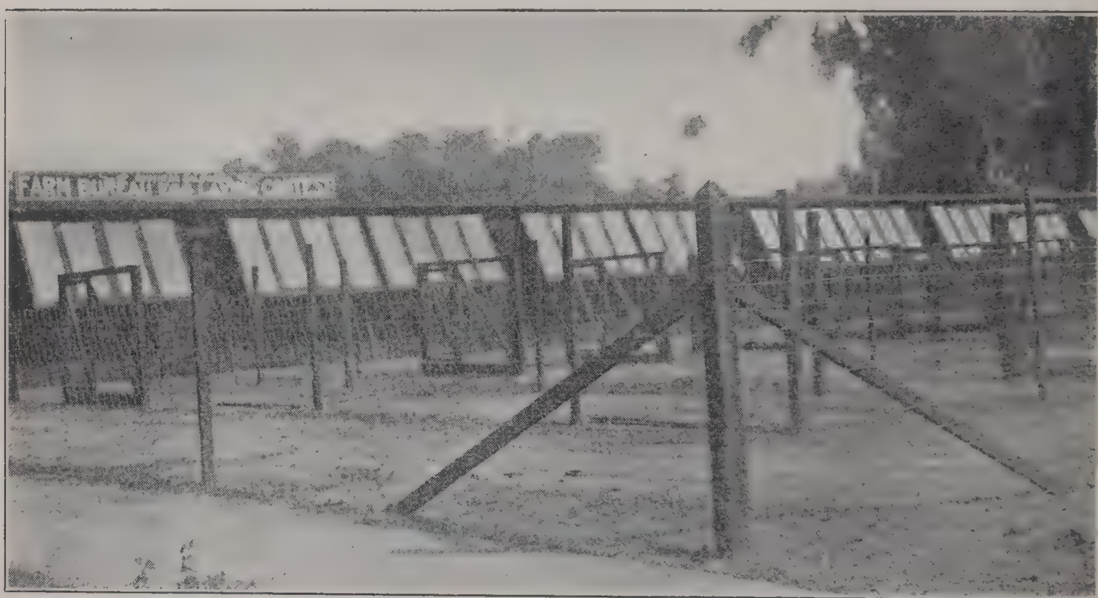


Fig. 158.—The egg-laying contest at Pomona, Los Angeles County, demonstrating the University type of poultry house. Three such egg-laying contests are located in the state, the other two being at Santa Cruz and at Petaluma.

Brooding: Coccidiosis Control Project. — During the past few years there has been considerable doubt on the part of the poultry raisers as to the value of coccidiosis control by means of isolation, sanitation, correct feeding, and plenty of buttermilk. The object of the project under way during the 1922 brooding season was to standardize the method of control and obtain accurate data as to results obtained. Eighteen demonstrations, with a total of 25,570 chicks, were conducted in five counties. Positive results were obtained at each demonstration, the mortality was lowered, and flocks brought back to normal condition within eight days after treatment.

Poultry Clubs.—Seventy-six poultry clubs were organized during the year. These clubs had a membership of 589 boys and girls. The

four-phase poultry club continues in popularity. This type of club carries the members through four periods and includes pullet development, egg production, breeding, and hatching. Eighteen club members in Sonoma and Los Angeles counties, in the four-period club, developed 4656 pullets and showed a profit of $2728. The members are now carrying the fowls through the egg-laying contest period, and are arranging for male birds to be used during the breeding period that will be carried on in the spring.

Fig. 159.—An agricultural club member in the four period poultry club contest in Napa County.

Egg Production Clubs.—There were 197 members with 15,145 laying hens enrolled. During the duration of the demonstration (155 days) 52,206 dozen eggs were produced.

Incubation Clubs.—There were 231 members completing the contests. There were 21,233 eggs set by members of the clubs, 15,957 chicks hatched, and 11,855 chicks raised to maturity. The total profit for the 428 members who completed was $13,165.04.

Livestock Disease Control.—Livestock disease control is largely in the hands of the State Department of Agriculture in California. Consequently, work done along this line by the Extension Service is the result largely of requested farm calls, with the exception of poultry diseases where definite projects for demonstrations in the control of coccidiosis and chicken-pox have been carried out. The coccidiosis work has already been reported. Ten counties report 107,020 birds vaccinated for chicken-pox as a result of demonstration

work. Two hundred and ninety-eight different farm calls were made by farm advisors and assistants on request for advice regarding poultry diseases.

Five counties had one or more farm centers adopting projects to have all family cows in the centers tested for tuberculosis, and in one county, Lassen, the farm bureau adopted a project to have the entire county declared a tuberculosis-free-area. In this project definite plans were worked out for systematic testing of all cattle in the county and for the disposal of reactors for slaughter. Up to December 1, 11,500 head of cattle had been tested, and 163, or 1.4 per cent, reactors discovered and disposed of. In Mendocino county two communities have been made tuberculosis-free-districts through the assistance of the United States Department of Agriculture. Under the California law, the county is the unit in declaring a tuberculosis-free-area, but in these districts the second tests were conducted by federal representatives and all reactors disposed of according to the agreement made with the State and Federal Departments of Agriculture. Thirty-two hundred cows were tested in the two districts. It is reported that this is the first work in the United States where only grade herds are considered in the establishment of an area of this character. In Contra Costa County, the Concord Center made a survey of the family dairy cows in the community, finding 90 cows belonging to 38 different owners. Through the coöperation of the State Department of Agriculture the entire number were tested and 14 reactors discovered. In two centers in Yolo County 36 family cows were tested and 7 reactors found. A total of 17,466 cows were tested for tuberculosis in 22 counties during the year as a result of extension work. In addition 255 animals were vaccinated against black-leg, 1900 hogs were vaccinated for cholera, and 162 farmers assisted in controlling contagious abortion.

FARM ECONOMICS

Farm Accounts.—The farm advisors report 1418 account books distributed and 448 completed records received. The Farm Management Demonstrator reports 57 one-day farm management schools conducted with an attendance of 1169. Of this number 845 expected to keep records in 1922, of which 815 will use the University account book. Sixty per cent of the 845 farmers kept some sort of record in 1921. Seventy per cent of them stated their intention to keep a detailed cost record in 1922. Final results of the 1922 work will not be available until late in the year 1922, when schools will again

be held in the same community. There has been a marked tendency in most counties to concentrate the effort in farm accounts to a limited number of farmers who wish to cooperate in this work.

Enterprise Cost Accounting.—There were 297 persons in 13 counties who were assisted in starting enterprise cost accounts. This work was the outstanding feature of the work of the year for the Farm Management Demonstration. Several cooperative marketing associations furnished cost accounting blanks gratis to such of their members as desired to keep records. As a result of the work done with the raisin growers in the San Joaquin Valley, the Sun-Maid

Fig. 106.—A farm accounting school in Nevada County. Fifty-seven such one-day schools were held, attended by 1162 persons.

Raisin Growers' Association employed a special man in their service department to spend his entire time in following up accounting work with the growers who were keeping cost of production records.

Farm Management Clubs.—During the year there was an attempt to try out as a boys' agricultural club project, the keeping of the records of the home farm. This type of club has not as yet proved successful.

Farm Building Plans.—The Division of Agriculture Engineering of the College of Agriculture has devised plans for certain farm buildings, which plans are duplicated and distributed in blue print form to inquirers. Each farm advisor has a complete portable set of these plans. The advisors report a total of 347 farm buildings built or remodeled according to plans furnished. Most of these

plans concern the housing of poultry or dairy cattle. Other plans in frequent request are those for the building of septic tanks. San Joaquin, Orange, Sacramento, and Mendocino counties report active interest in these plans.

Farm Labor.—The number of laborers supplied to farmers through the offices of the farm advisors is gradually declining, the number thus supplied being lower in 1922 than in any previous year. Only 1175 such laborers were supplied during the past year. The gradual decline of this activity is well shown in the following table:

1918	12,250
1919	5,443
1920	9,052
1921	1,818
1922	1,175

The only notable example of this work in the State during the year was in Sonoma County, where the hop crop was from 10 to 25 per cent heavier than normal and where a shortage of pickers threatened the loss of a considerable portion of the crop. The hop growers appealed to the farm advisor's office for help in the emergency. One of the two assistant farm advisors was sent to San Francisco for four days and there secured agreement from 144 pickers to come to Santa Rosa, 103 of whom actually arrived. Even after this, 17 per cent of the hops remained unpicked.

Farm Leases.—The farm advisors report on 47 farm leases which were drawn or modified by their offices. The Farm Management Division of the College of Agriculture has made a recent survey which indicates that although the foreign tenant farmer presents a serious problem there is no immediate cause for alarm. It is fundamental for the future welfare of the State that landlords have a farsighted view of the welfare of agriculture and that leases be so drawn as to provide for a permanent agriculture. It has been found that a long-term share lease is preferable in most cases. Most of the work done on leases by farm advisors has been in connection with their dairy improvement campaigns. In Stanislaus County 34 leases were modified by owners who are renting to foreigners, the new lease including the provision that the renter must test his cows. In Imperial County a model lease for dairy farms was drawn up by the Farm Management Division. This form was submitted to banks and other agencies. Several are now in use in the county and proving very satisfactory.

Purchase of Farm Machinery.—The farm advisors assisted 233 farmers in securing tractors, sprayers, ditching machines, or other

machinery to economize labor. The farm advisors in Mendocino and Sutter counties arranged for an interchange of farm machinery between farmers, and in both instances many pieces of machinery were interchanged with decided saving to those concerned. Several of the county farm bureaus have saved their members from 15 to 20 per cent by purchasing direct from a large farm machinery concern.

Tractor Schools.—The College of Agriculture provided a special budget for a series of tractor extension schools to be conducted under the direction of the Extension Specialist in Agricultural Engineering. Such schools were considered important because California is a State

Fig. 161.—A large truck was used to carry the equipment for the tractor schools, of which twelve were held in 1922, with an enrollment of 524 tractor owners or operators.

of power farming, using on its farms approximately 25,000 tractors, 45,000 gas engines, and 35,000 electric motors. The success of this comparatively new type of power depends very largely upon the knowledge and skill of the operators. Twelve one-week tractor schools were held through the farm advisors in the 12 counties of high tractor population, with an enrollment of 524 tractor owners or operators as students and 144 auditors. These schools especially emphasized repairing, overhauling, trouble-finding, adjusting, etc., with such excellent instruction as to enable the students to competently care for their own machines. Sixty-two tractors and eleven gas engines owned by the students were actually overhauled at the schools, while 55 new tractors, 27 gas engines, and over two tons of equipment were used for instructional purposes. During the period of the

schools the extension specialist had two assistants, since the instructional work was divided into three sections, one instructor having charge of each section. These one-week schools were scheduled every other week, that is the schedule allowed one week between schools in order that the extension truck could be loaded with the equipment, moved to the new location, and set up preliminary to the next school. The assistants took charge of packing, loading and moving the equipment to the new location while the extension specialist proceeded by train. Consequently, this interval of one week between schools allowed the specialist to spend a week with the farm advisor previous to the holding of the school, thus enabling the farm advisor to utilize the services of the specialist for such agricultural engineering problems as had accumulated. It should be especially noted that the schools were conducted for tractor owners, operators and those especially interested in power-farming equipment. They were not intended for high school students enrolled in agricultural engineering classes and consequently boys under 18 years of age required special permission before they were permitted to enroll. In this connection it is interesting to note that the average age of the students was between 35 and 40 years. As a result of this special effort to instruct the actual tractor owners or operators and the means taken to avoid the enrollment of young high school boys, the schools were very successful in reaching just those persons for which they were intended. The thorough organization of the schools, their complete equipment, and excellent instruction and the fact that the students actually overhauled and repaired tractors have brought great support to this extension activity. The extension specialist also conducted 22 one-day gas engine and tractor repair schools with an attendance of 551 students, at which 21 tractors and 9 gas engines were overhauled. In addition to the tractor work the specialist is conducting during the present year an extended series of one-day schools covering water installation, light installation, septic tank construction, and home sanitation.

Buying and Selling Associations.—The Agricultural Extension Service has full sympathy with the coöperative movement and when requested to do so extends such advice and suggestion as it has available. The College of Agriculture does not, however, enter the field to induce farmers to become members of any particular association, believing that this is a responsibility which farmers and those organizations which directly represent them must carry for themselves. Membership in such an organization brings with it the usual hazard involved in even the soundest business ventures. Nevertheless,

certain business organizations of farmers which have grown out of the advice of the Extension Service or which have been promoted by the farm bureaus, are mentioned in what follows, since persons interested in this report may be expected to be likewise interested in these coöperative organizations. It should be understood, however, that the organizations mentioned are entirely separate from the Extension Service.

Fig. 162.—At these tractor schools the farmers overhaul their own tractors and put them in repair. Sixty-two tractors and eleven gas engines owned by the students were actually overhauled at the schools, while fifty-five new tractors, twenty-seven gas engines, and over two tons of equipment were used for instructional purposes.

Hog Auction Sales.—These have been held either under the guidance of the California Farm Bureau Marketing Association or by individual county farm bureaus. While farm advisors have assisted by advice in the work they have in no wise been fiscal agents therein. The work and the results for the year 1921–1922 in the counties affiliated in the marketing association may be summarized as follows:

County	Cars	Consignors	Sales	Hogs	Top Price	Amount
Kern	75½	541	30	6,576	$11.90	$115,055.08
Tulare	208½	1,106	51	17,442	12.05	304,975.38
Kings	121	901	41	10,845	12.10	194,796.62
Fresno	35	170	25	3,258	11.85	51,973.32
Madera	28	235	16	2,700	11.70	45,437.81
Stanislaus	28½	406	21	2,383	12.00	42,010.03
	491½	3,653	184	43,204	$11.93 Average	$754,248.24

These figures indicate a change from the figures for 1920-1921 as follows:

	Cars	Consignors	Sales	Price	Amount
1920-1921	543	4,943	181	$10.82	$934,785.08
1921-1922	491½	3,653	184	11.93	754,248.24
	51½ Loss	1,290 Loss	3 Gain	1.11 Gain	$180,536.84 Loss

It is estimated that there was a gain to consignors of at least 10 per cent over current prices in the sales above reported.

Sutter County reports five demonstration hog sales carried on with the aid of the assistant farm advisor with a total cash turnover of $10,027.51, which in turn is an increase over current prices of from 10 to 12 per cent. Shasta County reports six carloads of fat hogs sold under farm bureau auspices totaling in value $10,500, the top price being $10.95 a hundred. These figures again indicate a saving to the producers of 10 per cent over current prices. The advantage of handling fat hogs under farm bureau auspices is now recognized by buyers and the sales are well attended by men from the various packing houses.

Other Pooling Arrangements.—The report from Inyo County presents features of interest as showing savings made by collective buying and selling where no marketing association existed but where the farm advisor took an active part in counsel and advice.

		Value of business	Saving
West Bishop Farm Center	One carload of salt, 20 tons	$ 400	$ 80
Big Pine Farm Center	Same	400	80
Potato Growers' Association	One carload certified potatoes, 21 tons, at 5c lb.	2,100	1,260
Owens Valley Alfalfa Association	10,000 tons alfalfa	200,000	50,000
Farmers' pooling alfalfa seed order	2,200 lbs.	440	66
Owens Valley Potato Association	60 tons potatoes	2,700	300
Owens Valley Apple Association, formed July 1922, sold	12,000 boxes	27,000	12,000
		$233,040	$63,786

The interests, and hence the needs, of the farmers of the State are quite diversified and therefore the farm bureau buying and selling activities are varied. In Madera County two farm centers are coöperating in buying supplies as follows:

40,000 grape stakes at a saving of $5 per M.	$ 200
5 tons trellis wire at a saving of $20 per ton	100
100 tons coal (2 cars) at a saving of $4 per ton	400
160 cords wood (8 cars) at a saving of $3 per cord	480
Total saving	$1,180

Los Angeles County reports a pooling arrangement for handling potatoes. This work has been done under the advice of the Extension Service and in coöperation with the potato grower members of the Los Angeles County Farm Bureau. The arrangement has proved satisfactory, a slightly better price has been realized, and approximately half the potato output of the county is now handled in pooling associations.

Fig. 163.—A knock down type of septic tank form, which is repeatedly used for building tanks in a community. Twenty-six counties were active during the year in the construction of septic tanks. Fifty-three meetings were held, attended by 1254 persons. There were 325 septic tanks actually built.

Sacramento County reports an "All American Strawberry Growers' Association" which has a membership of 100, covering some sixty acres of strawberries. As a selling organization it has proved to be satisfactory to the small grower.

Napa County reports a failure of "Meat Rings" primarily directed by committees from farm bureau centers. These "Meat Rings" were planned to supply retail buyers, and their failure can be traced primarily to the scattering of trade among competing shops.

Many reports of major or minor importance are noted, and on the whole the major buying and selling associations have been successful in making savings for their members. The few failures that

have occured can, we believe, be traced to the very human tendency to buy in various markets; in other words, to scatter trade.

Farm Bureau Exchanges.—Some years ago the farm bureaus promoted a plan for a general or miscellaneous buying and selling agency known as a farm bureau exchange. These exchanges were carried on by the various local and county farm bureaus. The farm advisors have taken no responsibilities in their operation. Their success has been satisfactory in some cases, while in others disaster has followed the effort.

Fig. 164.—The septic tank form in place, showing the concrete mixing box alongside. All is now ready for the demonstration.

Mendocino County reports as follows on the successful operations of its marketing exchange: 42 cars of hogs shipped; 14 cars of hogs sold locally; 21 cars of cattle shipped; 13 cars of cattle sold locally; 33 cars of sheep shipped; 12 cars of sheep sold locally; 3 cars of hay sold locally; 4 cars of grape stakes shipped; 42 head of dairy cows sold locally; 8 head of horses sold locally; 84 tons of seed and feed sold locally. Some poultry and farm machinery was sold locally. Miscellaneous purchases such as fertilizer, feed, explosives, etc., were made, amounting to $3986.16. Total value of business on which commissions were collected $138,311.54. Value of business on which no commission were received $50,000.

The Monterey County Marketing Exchange has coöperated with the Extension Service in its endeavor to improve the livestock of the county and has placed on farms 13 pure-bred swine, 3 pure-bred dairy animals, 1 pure-bred ram, and 2 pure-bred beef animals.

Sutter County reports as follows on the successful operation of its exchange: "Under the Farm Bureau Exchange we have handled, in terms of money, the following: Cover crop seed, \$321.54; spray (for the control of tree diseases), \$8219.87; lime (for soil improvement), \$318.30; alfalfa seed, \$205.21.

Santa Barbara County reports a business mainly in purchasing such supplies as pumps, irrigation outfits, fencing, pipe, and similar materials. The total business done amounted to \$28,700 with a reported saving of 20 per cent, or \$5740.

Kings County reports as follows:

Total business done by the Exchange	\$136,944
Total estimated saving to members	19,154

In some cases the record of the farm bureau exchanges is good, although a few disastrous failures are reported. These in each case seem to be due to lack of coöperation on the part of members in regard to keen competition and the scattering of trade. The Tehama County report touches a fundamental weakness when it states: "A combined purchasing and selling agency is not desirable as the two are working in opposite directions."

Grain Marketing.—The State Farm Bureau Exchange to which these various county farm bureau exchanges are linked reports as follows: "The California Farm Bureau Exchange started out as a general exchange to market miscellaneous crops; in fact, the State Exchange was formed to meet a demand created by the different county exchanges, which handled a great variety of products. This system of organization met with very little success. As a result, the State Exchange was reorganized on the basis of a grain marketing organization; yet it retained and still retains a purchasing departtnme that purchases supplies for the different county exchanges. The first step in the reorganizing of the Farm Bureau Exchange and establishing the Grain Department, was in finding a direct road to world markets. This was accomplished. The next step was that of securing adequate finances in order that satisfactory advances could be made to growers holding grain, or consigning it to the pool. This was necessary in order to prevent a surplus of grain being thrown upon the market at one time, thus unduly depressing the same, and in giving the law of supply and demand an opportunity to function normally. To this end contracts were made to advance money to growers up to the extent of \$3,000,000. The third step was that of securing the grain to market. To this end a campaign was put on in each of the grain growing counties of California and as

a result some 380,000 acres were signed up in 1922 on growers' contracts to be marketed through the Grain Department of the California Farm Bureau Exchange.''

It will be noted that the handling of a great variety of commodities met with but indifferent success and has been largely abandoned. On the other hand large enterprises in selling commodities have been a success.

Grain Elevators.—The California grain elevator development is distinctly a Farm Bureau Federation activity, and, while the farm advisors in grain-growing sections have at various meetings explained

Fig. 165.—A community demonstration of building the septic tank, San Diego County.

the system, their connection with it has been advisory only. The California State Farm Bureau Federation reports on this activity as follows: ''The California Farm Bureau Federation organized and brought into existence the California Farm Bureau Elevator Corporation, a profit-sharing corporation with a million-dollar capital stock, for the purpose of building elevators in California to handle the grain crop in bulk, thereby doing away with the laborious and expensive sack system. This is an organization created for and by the farmers the purpose of which is to facilitate the handling of the grain crop of California, thereby cutting down the farmer's expense of handling and enabling him to receive the full benefits of properly preparing his grain for the market, by way of cleaning, grading, blending, etc., all of which adds materially to the market value of the grain.

"There have been five elevators built to date located at Patterson, Montpelier, San Lucas, Lincoln, and Salinas. In addition to the country houses mentioned above, the California Farm Bureau Elevator Corporation has a long-term lease upon the million and a quarter bushel terminal elevator located on the waterfront of Oakland. This elevator is equipped to handle grain either in bulk or sack. The expense of running grain through the terminal or any of the country elevators is only 50 cents per ton for cleaning, being incidental compared with warehouse rates, which run from $1.50 to $2.50 a ton. The farmers contributing to and building these elevators receive the benefits of these rates and also the added benefits of having their grain properly prepared for the market. The plan is to go forward with the elevator building program until an elevator has been erected in each of the grain-growing districts of California."

The actual amount of business handled by the various elevators in 1922 was as follows:

Places received	
Patterson	2,060 tons
Montpelier	2,610 tons
Lincoln	1,800 tons
Salinas	1,500 tons
San Lucas	2,230 tons
	10,200 tons

Grain received	
Oats	1,400 tons
Wheat	2,450 tons
Barley	6,350 tons
	10,200 tons

RELATING TO THE FARM HOME

HEALTH: *Sanitation (Septic Tanks)*.—Twenty-six counties were active during the year in the construction of septic tanks, 13 of which had included the subject of sanitation in their programs of work with written projects. Thirteen hundred fifty-four attended 53 meetings, many of which were held at demonstrations on a farm where a septic tank was constructed. As a result of this activity, 325 septic tanks were actually built. Doubtless one of the reasons for an increase over 1921, when 226 tanks were reported built, is due to the knock-down septic tank form which can be used a number of times. A circular describing its construction was prepared by the Agricultural Engineering Division and issued by the Agricultural Extension Service. In several counties the farm bureau has built the forms and rents them. A specialist from the Agricultural Engineering Division gave demonstrations in its use. Tanks built at several schoolhouses offer community demonstrational opportunities.

In Los Angeles County, as a part of the rural sanitation project, a column in the Farm Bureau monthly is used by the county health

officer. And in Santa Cruz County, where fly control is a part of the health project, the poultry manure bins installed in 1921 were cleaned regularly, 700 tons being hauled to the orchards.

Home Nursing was adopted as a project in two counties in six centers, four of which are still in progress. Necessarily such a project must be conducted by means of demonstrations of methods and preparations for the emergency of illness. Forty home demonstrations were started, 30 of which were completed, with 10 still in progress. Twenty-six talks and demonstrations were conducted, attended by 261 people. Goals were set for the making of equipment, resulting in 17 medicine closets renovated and re-stocked, with

Fig. 166.—A corner of a room before and after improvement, as a part of a demonstration in a home furnishing project. Left, the original room. Right, as improved. Note that a closet is built under the stairs for coats, and the window has been enlarged to let in more light. More restful furnishings have been devised, San Diego County. Four hundred and sixteen rooms in 320 homes carried out some phase of this project in the state.

antidote charts posted on the doors; 30 sets of bed blocks made; 2 bedside tables (for neighborhood use), and 2 bed cradles (also for neighborhood use). The coöperation of physicians and nurses in carrying out this project has been valuable; 90 families report having adopted suggestions.

Water Supply Systems.—In three counties, where four demonstrations were held, 26 water supply systems were installed in farm homes, and 10 more planned. In one county the agent assisted in investigating two springs, for one of which plans were made to use a hydraulic ram to place running water in the home. In another county 8 systems are being planned in one center where at present the water is obtained with a bucket from the creek.

Lighting Systems.—In five counties four demonstrations of methods were conducted, and 63 lighting systems were installed in

farm homes. In one center in Kings County, where electricity was secured through community effort, lighting systems were installed on 50 ranches.

IMPROVEMENT OF HOMES AND GROUNDS: *Home Furnishing.*—Following the fundamental principles of health, efficiency and attractiveness laid down for home demonstration work in California, the home furnishing project has for its object to make the home an easier place for the housewife to care for, and a more comfortable and attractive place for the whole family to live in. Walls are

Fig. 167.—A home demonstration agent planning a demonstration in home ground improvement with the demonstrators, Stanislaus County. Sixty four such demonstrations have been started at which thirty-two meetings have been conducted, with an attendance of 692 persons.

made restful to look at; furniture is done over to be easier to care for and to harmonize with the surroundings; floors are made more comfortable to walk on and easier to keep clean; floor and wall plans are changed to lessen steps and admit light. Accessories are made only as rooms need them from a standpoint of color harmony.

The project starts with the enrollment of home demonstrators who wish to improve a living-room. Later other rooms in the home are worked on, until the entire house has been adapted to the needs of the family. Eight counties carried on this project in 65 centers; 309 demonstrations were started, 190 of which were completed, 110 worked on, totaling 416 rooms in 320 homes which carried out some being in progress, and 9 discontinued; 107 follow-up rooms were

phase of the project. Five hundred four pieces of furniture were made or done over, 244 walls or floors or woodwork treated, and 733 accessories made or suggestions followed.

Girls' room improvement has been an interesting sub-project of home furnishing. Two counties have carried on the work with a total of 37 rooms done over. The girls were taught all the processes for doing their work. The majority of the girls were agricultural club members.

Home Ground Planning.—Seven counties report work in home ground planning, four of which are following written projects. These

Fig. 168.—The clothing project still continues to be popular. A project leaders' meeting on taping dress forms and making guide patterns, Solano County. These volunteer project leaders carry on demonstrations in the centers. During the year, 8382 garments were made or remodeled and 1913 guide patterns were cut and fitted. These save an infinite amount of labor for the housewife.

are following the plan of locating demonstration yards in each center adopting the project. Sixty-four such demonstrations have been started, 45 of which are completed, with 19 in progress. Thirty-two meetings and home visits have been conducted with an attendance of 692. A specialist from the Landscape Gardening Division has assisted in two counties where in September 19 of the demonstrations were started by conferences and meetings held on the grounds to be improved. Blue prints for each home demonstrator were then made.

Home Management: *Home Accounts.*—Seventy-nine home demonstrators in five counties are keeping home accounts. In two other counties where the work was projected last year the activity has continued. Thirty-one women have budgeted last year's expendi-

tures. A one-day home account school with an attendance of 14 was held in Kings County. Forty-three families are reported as changing their ways of living as a result of expense records.

Home Equipment.—Sixteen centers in four counties adopted this project. Seventy-eight home demonstrations were started, 35 were completed, and 34 still in progress. In addition to the work carried on in these four counties, various pieces of household equipment were acquired in seven other counties as a result of Agricultural Extension work. In one center in each of the counties electricity was installed

Fig. 169.—A project leaders' meeting on hat making and designing, Contra Costa County. During the year 4089 hats were made or remodeled.

through farm bureau activity and in consequence several homes installed electric lights and purchased electric equipment. Results in the 11 counties reporting on this project follow: heating systems installed, 3; electric or solar heaters, 6; kitchen sinks and other plumbing, 40; septic tanks, 86; home evaporators, 258; iceless refrigerators, 2; fireless cookers (bought or made), 86; pressure cookers, 36; washing machines, 46; electric appliances, 44; tea wagons, 3; thermometers for preserving, 77.

Home Methods.—Forty-five kitchens have been rearranged as a result of work on this phase of the home management project in three counties. This includes adding windows for more light and air, sinks installed or raised in height, tables raised, stools secured, stove heights adjusted, working equipment rearranged, surplus

equipment disposed of, needed equipment bought and tested, and methods of work tested and adopted. Thirty-one home demonstrators are still at work on this project.

Clothing.—Clothing for health, efficiency, and attractiveness is the foundation of the clothing projects adopted by the 233 communities which started 433 demonstrations. Of these 296 have been completed, 108 are reported still in progress, and 29 discontinued. Eight thousand three hundred ninety-five families are reported as adopting suggestions.

The subject matter is developed by the home demonstration agent assisted by trained project leaders. New subject matter is available to the home demonstration agents from the specialist by means of regional conferences, by visits from the specialist to the agents in the counties, and by distribution of mimeographed materials. The project leaders are trained either by the specialist or the home demonstration agents.

The choice of subject matter is based upon a self-determined program of work which is submitted by the women, who meet and decide problems to be undertaken, to the chairman. The subject matter includes the following problems: clothing for health; dress forms, their covering, taping, mounting; guide patterns, color and line applied to clothing; corsets; shoes; machine efficiency; undergarments; neighborhood frocks; house dresses; renovation and remodeling; children's clothing; infant's layette; hat selection and construction.

Short-time clothing projects were adopted by seven unorganized counties. The specialist trained 387 project leaders to develop this work.

During the year 8382 garments were made or remodeled, 685 garments were dyed or dry cleaned, 1913 guide patterns were cut and fitted, and 4089 hats were made or remodeled.

Food Production: *Home Gardens.*—The more general adoption of the nutrition project, which stresses the use of vegetables and fruits and the ill effects of their absence in the diet, especially for growing children, has resulted in the planting of 43 demonstration winter gardens. In Sacramento County a demonstration garden, 25 x 50 inches, planted in the spring and planned to supply a family of four with vegetables the year around was very successful. Fourteen gardens are reported from the Imperial Valley as a result of a garden project carried on last year. These gardens, averaging about one-eighth acre in size, are usually planted in long rows next the field crop or near the house, where they can more easily be irrigated and cultivated.

In two counties roselle was grown by 40 home demonstrators. The roselle is an annual tropical plant, the unripe seed pods of which are used for making rich red jelly with a flavor somewhat like that of currant.

Home Poultry Flocks.—Farm poultry work has been carried on so successfully during the past few years that the projects are either no longer needed or have been incorporated in the commercial poultry projects. Where the work still continues 42 families in 10 counties reported on the project, which was supervised by the poultry specialist. Below is given the results of the work with the farm

Fig. 170.—Building the home evaporator as a demonstration in a country schoolhouse, Nevada County. Eighty-five such demonstrations were held, attended by 2807 persons. A total of 226 such evaporators were built during the year.

home demonstration flocks: number in flocks 4030; number sold 1460; number used in homes 540; number standard bred chickens purchased 675; dozens of eggs produced 26,372; dozens of eggs used in homes 1392; value of chickens and products sold $10,613; value of chickens and products used at home $946; number of flocks culled 48; total number in flocks culled 4742; number of birds eliminated 2018; estimated saving $1500; number of new poultry houses built 14; number of poultry houses remodeled 3.

Dairying.—Home cheese making is reported from five counties. In two counties local women, successful cheese makers, gave the demonstrations. Nine hundred thirty-two pounds of cheese valued at $262 were made. All but 43 lbs., which was cottage cheese, was of the cheddar type. Seventy-five pounds are reported sold for $25.

Food Preservation and Selection: *Home Evaporators.*—The result of the series of demonstrations on home evaporation of vegetables and fruits given during the season of 1921 justified the continuance of the service. In April 1922 a questionnaire was sent to the home demonstrators of 1921 requesting them to state their estimate of the value of evaporated products, and the extent to which they were included in the winter diet. Eighty-four per cent of those reported: (1) The family relish evaporated products.

Fig. 171.—A demonstration of the use of evaporated products made in the home evaporator before a group at a picnic, San Diego County.

(2) A greater variety of fruits and vegetables had been served. (3) The work of planning and preparing the meals has been lessened. (4) I will continue using the evaporator. During the past season the variety of products prepared in the evaporators has increased and included various kinds of fruits, fruit butters, and fruit sweetmeats, various kinds of vegetables, soup vegetable mixtures, tomato paste, corn dried on the cob, and beef.

The specialist spent 121 days in the field visiting 19 counties, held 85 demonstrations, and gave 20 talks at meetings, with total attendance of 2807. At the demonstrations 99 evaporators were built, and 117 reported built later.

Food Preservation.—One hundred forty-six centers in twenty-five counties report results on some phase of food preservation work carried on through the Agricultural Extension Service. In the counties where home demonstration agents have been working for more than a year, demonstrations of the cold pack method of canning and the use of the pressure cooker in processing were given by project leaders, the agents giving the demonstrations in the new centers only. In four of the counties recently organized for home demon-

Fig. 172.—The results of a mother and child project in nutrition work, Tehama County. These babies are an evidence of the value of proper prenatal nutrition and subsequent correct feeding.

stration work, six classes in canning and jelly making were held for training project leaders to assist the agents in giving the demonstrations.

In seven counties 30 home demonstrators made food budgets providing for an adequate diet for their families for the entire year and canned, dried and stored vegetables, fruits and meats in accordance with its provisions. Work on these budgets, one agent reports, has resulted in more thought being given to the family diet, more vegetables being served, and has stimulated a greater interest in nutrition.

Tests for pectin and acid and the use of the thermometer and other tests in jelly making were demonstrated in 52 centers in 7

counties. This work included the making of pectin and the use of commercial pectin in making jellies and jams.

Results of food preservation work following the demonstrations given are as follows: canned fruit 26,873 qts.; canned vegetables 8670 qts.; canned meat (including poultry) 1596 qts.; canned fish 45 qts.; brined vegetables 169 qts.; jams and jellies 14,514 qts.; dried fruits 9230 lbs.; candied fruits 425 lbs.; dried vegetables 2568 lbs.; pork cured 475 lbs.; lard made 100 lbs.; other meat and by-products 24 lbs.; total estimated value of preserved products $18,802.

Fig. 173.—Some demonstrators in a nutrition project in Santa Cruz County. The upper lines on the chart show the proper weight for each child. The lower lines represent the actual weight and subsequent gains of each of the children. These projects are carried on in the home by coöperation with the parents.

Canning Clubs.—Canning club work is reported from two counties. In Nevada County the work was projected for the first time, and one club of six members was organized. Three of the girls completed the work and attended the Agricultural Club conference at Davis.

In Shasta County, where the work has been in progress for several years, seven clubs were organized with a membership of 55. Eighteen girls completed the requirements and 26 did part of the work. Forty-three girls canned 1717 quarts of fruit, vegetables, and meat. Six winners attended the Agricultural Club conference at Davis.

Nutrition work was carried on during the year 1922 in only a very limited way in a few counties in order to try out plans and to have a background for carrying it on permanently in a thorough and effective manner.

The work planned and in progress for 1923 is as follows: counties adopting one or more phases of the project 17; communities 125; meetings to be held in relation to project, either discussion or demonstration, 541; project leader training classes to be held 15. In food selection and preparation there are 182 demonstration homes and 859 homes are expected to adopt suggestions. In child feeding there are 103 demonstration homes and 194 homes are expected to adopt suggestions; 24 school lunches are being started.

The nutrition work as carried on in the various counties includes the following:

1. Right food for all members of the family group, a consideration of selection, preparation, production and preservation of food, and a training in food habits.

2. Communities influenced to serve better selected or prepared food. (Farm bureau banquets and refreshments at meetings, community picnics, farm home department lunches at project leader and county committee meetings.)

3. Corrective diet for individual or group. A correct weight group with an attendance of 40, representative of most of the 16 centers in one county, meets monthly to determine their progress toward normal weight and to consider and report the methods which include a nutrition and exercise program.

4. All nutrition work taught through demonstrations of correct food preparation in 11 centers in one county.

5. Community coöperation in bringing all the school children in the community to normal health.

6. Mothers influenced to practice eating good food and other health habits for themselves during pregnancy and nursing and for the child through infancy. Two counties have each a farm home department where this "mother" project is the major nutrition work. A few counties are carrying on this work with individual mothers.

AGRICULTURAL CLUBS

The types and kinds of agricultural clubs have already been described under the various sections of this report. The supervision of agricultural clubs, as in previous years, has been divided between three assistant State club leaders, who each have charge of one division of the State. This division of territory coincides with that supervised by the assistant State leaders of farm advisors. The local leadership in each county is divided between the several farm advisors, who are in direct charge of all extension work in their

counties, high school teachers of agriculture, farm bureau project leaders, and deputy county superintendents of schools, etc. The following table shows the amounts of leadership given by each one of these types of club leaders, and the quantity of work done:

Numbers of leaders	Title of leader	Total number of club members	Total number members reporting	Average number members per leader	Average number reporting per leader	% completing per leader
35	Smith-Hughes teachers	909	606	26	17	66%
*9	Local club leaders..........	444	337	49	37	76%
1	Dept. Co. Supt. Schools	65	56	65	56	86%
3	County club leaders	401	350	134	116	87%
9	Farm advisors................	523	400	58	44	76%
1	Cow tester........................	6	0	6	0	0%
1	Project leader..................	4	3	4	3	75%
Total 59		2352	1752	40	30	74%

*NOTE.—Local club agents are high school teachers of agriculture who are coöperatively employed on a part time basis to conduct club work in their high school districts.

Fig. 174.—A volunteer project leader making a hot dish supplementing the lunch in a rural school. Members of the farm home department in the various centers take turns preparing this lunch daily for the children.

As in the past, local high school teachers of agriculture have acted as local supervisors for most of the club demonstrations in the State. The State Supervisor of Smith-Hughes teachers of agriculture requires that all of the teachers who receive State and Federal funds shall conduct some club work in connection with their regular school work under the direction of the Agricultural

Extension Service. In counties where there is a farm advisor, the work is planned in connection with his demonstration program. In counties where there is no farm advisor the work is in immediate charge of the assistant State club leaders.

The following table shows the financial summary of the clubs:

	1919	1920	1921	1922
No. clubs	216	313	289	310
No. standard clubs	139	192	182	188
Enrollment	2,084	2,798	2,351	2,352
Number records	1,249	1,660	1,672	1,752
Value of products	$63,306 90	$138,303 21	$126,241 .51	$152,611 .65
Cost of production	$34,376 .37	$78,364 .33	$79,259 .88	$107,887 .72
Net value	$28,930 53	$59,938 88	$46,981 .53	$44,723 .93
Average net per member reporting	$23 17	$36 10	$28 09	$25 .52

Fig. 175.—Enjoying the hot school lunch in a rural school, Santa Cruz County.

COMMUNITY PROJECT ACTIVITIES

SCHOOLS: *Consolidation.*—The consolidation of the country school is proving very successful from the reports of the farm advisors. In only 13 school consolidations, however, did the farm advisors participate actively.

School Grounds.—Beautifying school grounds continues as a part in the farm advisor and home demonstration agent's activities. Thirty-three country schools were assisted along this line, the farm

advisor often making the planting plans. Playground equipment for two schools has been placed as a result of farm home department activities.

Rooms.—In eight counties 13 school rooms have been reported as remodeled, or have been built as additions to schools, some as auditoriums and others as school rooms only.

COMMUNITY REST ROOMS.—Three community rest rooms, started in former years, continue to be appreciated, as shown by the increased use made of them by farm women and children. Butte County reports that the register indicates nearly a doubling in the number of visitors who come from all parts of the county.

Fig. 176.—The president of a boys' agricultural club speaking before a group of farmers on the value of agricultural club work in his county, Los Angeles County.

A rest room was started during the year in Merced County, as a result of activity by the County Farm Home Department Committee, and made possible of realization through the coöperation of several groups of people. The Chamber of Commerce remodeled the building; the women of the various farm centers raised money for furnishing, supplemented by donations from merchants; and the city of Merced furnishes lights, fuel and water. A matron is in charge, paid jointly by city and county. The need and value of the room are shown by a registration of between 350 and 400 people each month.

COMMUNITY HALLS.—Meeting halls are very essential for farm bureau center meetings, and as a result of such needs, 14 new community halls they been made available.

ROAD IMPROVEMENT.—The report of road work, of course, does not include figures on all the road work that has been accomplished by county farm bureaus in California. Many farm advisors can only report that farm bureau centers were more or less active in road improvement. Five hundred seventy-one miles of roads, however, were improved by dragging, gravelling or paving. Three new bridges were built as a result of farm center activities. One farm bureau center alone caused 11 water tanks to be built along county

Fig. 177.—Rural fire companies still continue active. One hundred and twenty such volunteer rural fire companies were maintained in 1922.

roads for sprinkling purposes. Another county reports 210 miles of road improved as the result of a road project drawn on a county-wide plan, a saving to the county estimated at $11,200.

FIRE PROTECTION.—The project for rural fire protection, first inaugurated in a state-wide way in 1917, continues to be an important part of the community assets in rural California. The volunteer rural fire company with a trailer which can be hitched to any automobile is a common means of rural fire protection. These companies, first formed as a means to control grain fires, have since come into use for all kinds of rural fire protection. So great has been the

spread of influence of this plan that it has almost been forgotten that it was a California farm advisor who first devised and promoted the trailer equipped with fire extinguishers, water cans, shovels, sacks, etc., and that it was another farm advisor who built upon this plan to devise the rural fire company from which the Agricultural Extension Service has promoted the project over the State. In 1922 it was known that 120 rural fire companies were maintained in fifteen counties. In these counties there are 36 officially appointed wardens. Doubtless a large number of other counties maintain fire companies not here reported since in many places the plan has there passed beyond the stage of demonstration into an established practice in which the farm advisor has no longer any direct concern.

PUBLIC SERVICE

One of the activities of the Agricultural Extension Service is centered in the Public Service Office at Berkeley. Inquiries for agricultural information, whether addressed to the College of Agriculture and Experiment Station at Berkeley or to the Extension Service, are cared for by this office. During the past year approximately 15,100 letters were written in reply to specific questions on California agriculture. A small percentage of the letters received deal with some particular phase of a subject which can be best answered by the specialist in the division concerned. Such inquiries are referred to the proper office for attention. The handling of routine correspondence, much of it similar in character, is not an easy task, yet the Public Service Office feels that the time and effort necessary in answering each letter with a personal reply is well spent. The notes of appreciation received and the general attitude of the people throughout the state toward the activities of this office are extremely gratifying. During the year 633 persons visited the office seeking agricultural information. A considerable percentage of these were persons who had questions to ask on the agricultural possibilities in certain sections of California, or who desired detailed information on the methods of handling a specialized crop. Telephone inquiries to the number of 515 were received, principally from people living in the San Francisco Bay region who had some backyard garden problems to solve.

During the past twelve months 637 letters were written to persons not living on farms but who expressed a desire to engage in some agricultural pursuit in California. As a large proportion of these

inquiries for agricultural information come from people who have never visited the state, particular care is exercised in the replies. Available literature on the phase of agriculture in which the inquirer is interested is sent, also the publications of the Experiment Station prepared especially for the prospective settlers in California; their attention is called to the necessity of a careful study of the soil and irrigation and drainage problems found here, and special emphasis is laid on the capital necessary to insure success in an agricultural venture in this State.

Blue print plans for farm structures are loaned by the Agricultural Extension Service. Fifty-five different plans are now available. These have been prepared by the Division of Agricultural Engineering and the divisions concerned. During the past year 988 of these plans have been loaned from the Berkeley office to those making a request for plans of this character.

CORRESPONDENCE COURSES IN AGRICULTURE

During the year ending May 1, 1923, 1896 students enrolled for agricultural correspondence courses conducted by the Division of Agricultural Education. This was an increase of 29 students over the previous year, indicating that continued interest in this form of agricultural extension work may be expected.

Approximately 31 per cent of the students enrolling were farmers, 19 per cent tradesmen and mechanics, and 10 per cent housewives. This indicates that the courses are not only reaching the farmers and their wives, but that they also have an appeal to persons in other lines of work who may in the near future turn to agriculture for a livelihood.

Students enrolled from every county in the State excepting Alpine, Del Norte, and Mono. Los Angeles County led with 208 students. Thirty-nine other States and 19 foreign countries were also represented in the correspondence course enrollment.

The Division of Agricultural Education sent out 72,450 pieces of mail during the year in the dissemination of agricultural correspondence courses. Fifteen thousand four hundred ninety-eight lesson papers were corrected, 23,493 new lessons were sent out, and the dictated personal letters numbered 4031.

Sixty-five per cent of the lessons sent out were answered. This is considered very good in view of the fact that the courses are taken solely for the assistance they may give the student in his work, no academic credit being offered.

Lessons given away to the University of California faculty members and to other institutions, including county farm advisors and agricultural instructors in California amounted to 6665, or 22 per cent of all lessons sent out. This public service phase of the correspondence course work has met the approval of a large number of farm advisors, high school agricultural teachers and members of the College of Agriculture, who desire concise information on special farm crops and animals. Many lessons were sold at actual cost to other educational workers and students who were not entitled to them free of charge.

Three new courses (Apple Culture, Berry Culture, and Farm Bookkeeping and Cost Accounting) were added during the year and two new courses (Strawberry Culture and Turkey Raising) were partly written. A total of 32 agricultural correspondence courses are now available and two more are being prepared.

SUBJECT INDEX

AUTHOR INDEX